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AT HARVARD COLLEGE.

Vol. LXVII. No. 1.

SOME TRILOBITES OF THE LOWER MIDDLE ORDOVICIAN OF EASTERN NORTH AMERICA.

By Percy E. Raymond.

With Ten Plates.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

April, 1925.

No. 1.— *Some Trilobites of the Lower Middle Ordovician of Eastern North America.*

By Percy E. Raymond.

This paper is concerned primarily with the trilobites of the lower part of the Middle Ordovician of the Appalachian Province. It is based upon collections made by the writer during expeditions to Pennsylvania, Virginia, and Tennessee, the cost of which was defrayed by the Shaler Memorial Fund at Harvard University. These trips were made in 1917, 1918, and 1921, and although primarily for the study of the stratigraphy of the Ordovician formations of the region, it soon became obvious that the perplexing problems presented could not be solved until the faunas were described.

Knowing my interest in the faunas of this age, Professor Schuchert very kindly turned over to me for study and description all the trilobites collected by himself, and by Professors Twenhofel and Dunbar, on three expeditions to western Newfoundland. A number of these species proved to be undescribed, and others were represented by specimens which threw new light on their relationships. A collection made by the late Alpheus Hyatt in the same region many years ago also contains trilobites which added to the knowledge of this fauna.

In order to have material for comparison, the Chazy of western Vermont and northeastern New York was again explored in 1919, and a few new trilobites are now added to that rather extensive fauna.

Besides these strictly Lower Middle Ordovician species, a few others, more or less germane to the subject, are described. A trip to Clermont, Iowa, in 1917, produced a few new forms from that astonishingly fertile locality, and former students have been good enough to send me specimens from Missouri and British Columbia.

My thanks are due to Profs. Roy Holden of Blacksburg and S. L. Powell of Salem, Va., for specimens which they have enabled me to use; to Prof. E. W. Shuler of Dallas, Texas, for others collected during his study of Walker Mt., Va.; to Prof. R. M. Field for specimens collected while with me in Virginia in 1917; to Mr. A. G. Becker for assistance and specimens when at Clermont, Iowa; to Dr. Donald G. Barton for extensive collections from the Kimmswick of Missouri; to Dr. Francis P. Shepard for trilobites from British Columbia; and to Profs. Charles Schuchert, W. H. Twenhofel, and Carl O. Dunbar for the use of material from Newfoundland.

HYPOPARIA Beecher.

Agnostidae McCoy.

The Normanskill contains a few species of this typically Cambrian family, two of the forms, one in Newfoundland and one in Virginia, being locally rather abundant.

In describing an agnostid, one is in a somewhat embarrassing position, for recently the question has arisen as to whether the shield commonly called the pygidium is not in reality the cephalon. As a preliminary to the description of the species it is necessary to discuss that point.

In his article on an Outline of a Natural Classification of the Trilobites (Amer. journ. sci., 1897, ser. 4, **3**, p. 183), Professor Beecher stated that under favorable conditions of preservation the agnostids show on the ventral surface of the cephalon, "a distinct plate, separated from the cranidium by a suture," which "can be compared only with the free cheeks of other trilobites."

Beecher did not figure this plate, nor did he state on what species he had seen it, but mentioned having studied the collections in the Museum of Comparative Zoölogy. On examination of the collection in this Museum, I also found the plate on the ventral side of some agnostids as described by Beecher, but the shield which carries it is the one considered by all palaeontologists as the pygidium. The question therefore has arisen as to which shield in the agnostids really is to be regarded as the cephalon.

Before taking up the argument it will be well to describe this plate in the various species in which it can be seen.

Agnostus nudus (Beyrich).

Plate **1**, fig. 1.

Battus nudus Beyrich, Ueber einige böhmische trilobiten, 1845, p. 46, pl., fig. 20.

Agnostus nudus Barrande, Syst. Silur. Bohême, 1852, **1**, p. 903, pl. 49.

This is one of the smooth agnostids (Phalacroma of Corda). The shield usually called the cephalon is quite smooth and evenly convex, without markings except for a concentric line a short distance from the margin which on exfoliated specimens delimits the doublure. There is no suggestion of a neck-furrow, but at the sides are a couple of

oblique furrows, demarking regions overlapped by the ends of the thoracic segments when the animal is enrolled.

The other shield, usually called the pygidium, is evenly convex in the central portion, but has a relatively wide border separated from the convex body by a rather deep furrow. It is on this border that the sutures and ventral plate are to be seen. The specimens are casts of the interior of the shield, and, when perfect, show no trace of the structures mentioned. The cast of the interior of the doublure is, however, thin and fragile, and either breaks away naturally or can be flaked off with a fine needle. When it is removed, there is revealed a pair of clean-cut sutures which unite on the median line at the front and run backward just within the outer margin, thus cutting off a yoke-shaped plate within the sutures. The plate is rather wide at the front, but tapers to points on either side, though it extends the whole length of the shield.

In spite of the fact that this plate occurs under what has been called the pygidium, it is impossible, on seeing it and its sutures, to think of it as anything else than an epistomal plate. Single shields of this species are of large size for agnostids and so show the plate and the sutures especially well. One shield is 6.5 mm. long, 5.5 mm. wide, and the epistoma is 1 mm. wide at the front. Other shields showing it well are 5 mm., 5.5 mm., and 6 mm. long. The specimens are from the Middle Cambrian at Teirovic and Slap, near Skrey, Bohemia. The one figured is M. C. Z. 1,686.

Agnostus integer (Beyrich).

Battus integer Beyrich, Ueber einige böhmische trilobiten, 1845, p. 44, pl., fig. 19.

Agnostus integer Barrande, Syst. Silur. Bohême, 1852, **1**, p. 900, pl. 49.

This seems to be the most common of Bohemian agnostids, and the M. C. Z. collection contains a large number of specimens, very many of which show the sutures and ventral plate on the shield called the pygidium. In this species these structures are actually so obvious that Barrande has represented them in one of his figures (Plate **49**, fig. 5b) though he does not mention them in the text.

This species (the type of Corda's Peronopsis) is of a very different configuration from *Agnostus nudus*, the axial lobe being developed on both shields. The one usually called the pygidium looks more like a cephalon than the other, as the median lobe is pointed, and in well-

preserved specimens shows three pairs of faintly impressed furrows. The axial lobe of the other shield, called the cephalon by authors, has a single cross-furrow and a pair of basal lobes. Cross-furrows are developed more often on pygidia than on cephala, though they are not unknown on the latter (Paradoxides, Crotalocephalus, and others) whereas basal lobes are much more common on glabellae than on axial lobes of pygidia. Some agnostids have basal lobes on both shields (*A. pisiformis*, *A. fissus*, *A. sidenbladhi*, etc.) so that no great importance can be attached to either of the above characteristics.

Agnostus bibullatus Barrande.

Agnostus bibullatus Barrande, Syst. Silur. Bohême, 1852, **1**, p. 906, pl. 49.

This species is rather rare, and there are only a few specimens in the collection. The ventral structures occur on what has been called the pygidium, but further than to satisfy myself of their presence I have not gone, owing to my reluctance to mar the little material we have. The general appearance of this species is much like *A. nudus* and the shield usually called the pygidium has more the appearance of a cephalon than the one usually so designated. It has a median tubercle, and dorsal and glabellar furrows, whereas the other shield is featureless. The specimens are all from the Middle Cambrian at Teirovic, Bohemia.

Agnostus rex Barrande.

Agnostus rex Barrande, Syst. Silur. Bohême, 1852, **1**, p. 908, pl. 49.

This is another large agnostid, and differs considerably from the other species. It is the type of Corda's genus Condylopyge. The sutures are well shown on several specimens of the shield usually called the pygidium. The ventral plate appears to be very narrow and is satisfactorily seen on only one specimen. On this the sutures meet just inside the margin and swing somewhat inward so that they are farther from the margin at the sides. The ventral plate, everywhere narrow, is widest at the front. This shield is 5.5 mm. long, 5.5 mm. wide, and the ventral plate is .25 mm. wide at the front.

The specimens are from the Middle Cambrian at Teirovic and Skrey, Bohemia.

Agnostus tardus Barrande.

Agnostus tardus Barrande, Syst. Silur. Bohême, 1852, **1**, p. 913, pl. 49.

This species is from the Upper Ordovician of Bohemia and it is therefore especially interesting to find that it shows the same sort of sutures and ventral plate as the species from the Middle Cambrian. In the specimen which shows the structures best, the ventral plate is twisted around through an arc of about 30° to the left, thus showing conclusively that it was free. As in the other species, the plate is on the shield usually called the pygidium, and here again that shield has more the appearance of a cephalon than of a pygidium. This species was the type of Arthrorhachis Corda.

The specimens are from Králový dvúr and Mt. Kosov, Bohemia.

In addition to the species in which I have actually seen the plate, there may be mentioned a few figures in which, having become familiar with the appearance, it is possible to make out, more or less distinctly, traces of the sutures.

Agnostus fissus Lundgren. (Lake, British Cambrian trilobites, pt. 1, Paleontogr. soc., 1906, **1**, pl. 1, fig. 1). At the posterior end a bit of the trilobite is flaked off showing the suture at the margin of the "pygidium."

Agnostus rotundatus Grönwall. (Lake, Loc. cit., pl. 2, fig. 3). This figure seems to show the suture on the left side of the "pygidium."

Agnostus barlowi Belt. (Lake, Loc. cit., pl. 2, fig. 7). This specimen appears to be flaked on the "pygidium" so as to show a large part of the ventral plate.

Agnostus dux Callaway. (Lake, Loc. cit., pl. 2, fig. 19). This specimen appears to show a part of the suture on the left side of the "pygidium" and is in such a condition that a little flaking off of the cast of the interior of the doublure would probably reveal the whole plate.

Previous Opinions. Barrande has given a list of the references to Agnostus down to 1852 and I have looked over most of them, as the M. C. Z. fortunately possesses nearly all the works referred to. So far as has been learned, the first person to figure an Agnostus was Magni Bromell, M.D., who published several articles on the fossils and rocks of Sweden in the Acta Literaria Sveciae, 1725–1729. Neither his description nor that of Wilckens (1768), Linné (1768), nor Modèer (1785) have any scientific value, though the specific name of *Agnostus pisiformis* is credited by courtesy to Linné, thanks to Wahlenburg, to

whom Barrande credits all references before 1821. Wahlenburg gave the first description, and, for his time, a relatively accurate figure of *Agnostus pisiformis*. Though he saw no complete specimens, he noted that there were two kinds of shields in the "Alum" shales of Sweden, and he considered one the head and the other the tail. The specimen he figured as the head would hardly be recognized as belonging to *Agnostus pisiformis*, but that called a tail is evidently the shield which Angelin and later authors have considered the head, the large basal lobes and the median longitudinal furrow back of the axial lobe being clearly shown. After Wahlenburg came Brongniart (1822) who founded Agnostus with *pisiformis* as the type. He gave a better figure than had previously appeared, but considered the truncated end of each shield the front, and the head and abdomen different varieties of the same species. Schlotheim (Nachtr. petrefactenkunde, 1823) believed that the status of Agnostus was very doubtful in his time, but considering the spines of some forms of *A. pisiformis* to be articulated like the antennae of Acarus, he denominated the spinose end the anterior.

Dalman (Svenska vet.-akad. Handl., 1826, p. 226) agreed with Wahlenburg in considering the shield which bears a furrow back of the axial lobe the pygidium, but none of the writers up to this date had any very convincing evidence for his beliefs.

Bronn (Lethaea geogn., 1835, p. 123, pl. 9, fig. 20) and Hisinger (Lethaea Suec., 1837, p. 19, pl. 4, fig. 567) merely follow Dalman, and therefore make the same designation of head and pygidium.

Milne-Edwards (Crustacea, 1840, **3**, p. 347) was the first to adopt the present method of naming the anterior and posterior shields, reversing the procedure of all who had preceded him. Although he figured them in the same position as was done by Dalman and others, he stated that "the one of them which is the larger and shows a median line back of the median lobe seems to be the cephalic shield, and that which does not show this line seems to be the abdominal shield."

Burmeister (Die organization der trilobiten, 1843, p. 56) at first thought that the shells of Agnostus represented the young of various other trilobites, and he called them all head-shields. After the publication of Beyrich's paper describing an entire specimen, he adopted that author's view as to which was cephalon and which pygidium, thus coming into agreement with Milne-Edwards. In his text and explanation of plates however, he makes contradictory statements.

The first entire agnostid to be found was a specimen of *Agnostus integer,* obtained in Bohemia and described by Beyrich. He says (translation):—

> Since in this genus neither eyes nor facial suture are present, only the form of the axial lobe can give information as to which shield is head and which pygidium. In that shield which I hold to be head, one sees a deep cross-furrow near the anterior end of the glabella. Its position corresponds to the united anterior lateral furrows of other trilobites, which here, as often happens, are joined to each other in one furrow. The part in front of this furrow is the "Stirn" [frontal lobe] of the glabella. In *B. pisiformis* still another furrow runs from the middle of the frontal lobe to the bordering furrow. This I will call the "Stirnfurche."

After Beyrich's time the question of which shield was cephalon and which pygidium seems to have been considered settled, for later authors, with the exception of Barrande, do not discuss the matter.

Hawle and Corda (Prodrom. mon. Böhm. tril., 1847, pl. 3) were quite haphazard in their orientation of specimens, though from their figures of the types of Phalacroma, Condylopyge, and Lejopyge one would infer that they depended upon the median tubercle to indicate the head, and all their "Battoides" (Arthrorachis, Battus, Peronopsis, and Pleuroctenium) are arranged with the spines pointing backward.

Angelin described and figured twelve species from Sweden, many of them from entire specimens, without discussing the method of orientation, merely following Beyrich.

Barrande (1852, **1**, p. 494–495) was the first to give a real and logical reason for the orientation he adopted, and his remarks follow (translation):—

> If one considers a complete individual, one may easily let himself be deceived on the normal direction, for this reason, that the thoracic segments are ordinarily concave toward the front, that is to say, they curve in a direction opposite to that observed in almost all other trilobites. One escapes this error, in cases where the species is ornamented with spines, either on the cephalon or pygidium, as in *A. granulatus,* for the direction of these ornaments indicates that of the body. In the absence of these signs, and when one has before him only isolated fragments, one may recognize the pygidium because it bears on its anterior margin the knees for articulation, which are lacking on the posterior margin of the head. It requires some care not to confound the knees of which we speak, with the elevated border which one finds at the front of the pygidium, or the occipital ring at the back of the head.

The important point in this is, of course, that which relates to the articulation of the segments. In all trilobites, so far as I know, the

front of each segment is overlapped by the posterior portion of the segment before it, and the cephalon laps over and the pygidium under, the adjacent segment. When agnostids are oriented as is the custom set by Milne-Edwards, Beyrich, and Barrande, the segments overlap one another in the same way as in all other trilobites, which is a strong argument for the correctness of their method.

Now that a plate has been found on the lower side of what is, in this orientation, the pygidium, it is necessary to take one of two positions. Either this plate is an extra plate of the pygidium, or the orientation adopted by practically all authors since Milne-Edwards is wrong, and all have been calling the cephalon the pygidium. The first possibility simply cannot be discussed, for nowhere in the whole class of trilobites has there ever been seen an extra plate on the ventral side of the pygidium; there is no reason to expect one; nor can one conceive how one could be formed. The under side of the doublure of pygidia is often seen, in fact is frequently sought out and studied, since in some groups, as for example in the Asaphidae, the extent of the doublure is of classificatory value, so that if a suture and plate were present on the pygidia of other trilobites the fact would be apt to be known.

There are numerous reasons, aside from the ventral plate, for believing that the agnostids should be oriented in a position the reverse from the customary one. If Plate 6 of Angelin's Palaeontologia Scandinavica is reversed, I think the figures will appear more natural. In the accepted position the tip of the pleura of the thoracic segments and the pleural furrows point forward; in the reversed position they point backward, as in all other trilobites. In the accepted position every species has a tubercle on the median line of the pygidium; in the reversed position this would be on the cephalon, where it usually occurs. In the accepted position the cephalon is in general more smooth than the pygidium; in the reversed position the pygidium is the smoother, as is the rule among trilobites. In the accepted position the glabella is more smooth than the axial lobe of the "pygidium," a condition practically unknown among other trilobites; in the reversed position the axial lobe of the anterior shield usually shows three pairs of furrows, the normal number of glabellar furrows in most trilobites.

Turning to Plate 49 of Barrande's work (Syst. Silur. Bohême, 1852, 1) it will be noted that the above remarks hold equally well with regard to the species described by him. A difficulty arises, however, in regard to the spines of *Agnostus granulatus*. One of the reasons for the conventional orientation has been that spines in trilobites normally

point backward, and the pygidium is apt to be more spinose than the cephalon. Exceptions to these rules are, however, rather numerous. All the Raphiophoridae violate both, various species of the Proëtidae, Phacopidae, and Odontopleuridae have numerous forward-pointing spines on the front of the cephalon, and even such a thing as a trilobite with forward-pointing spines on the thorax is known, though it is not a common feature. Spines of any length are exceedingly rare among the Agnostidae, and the short stubby spines usually seen could as well belong to the cephalon as the pygidium. The only important argument against reversing the usual orientation of the agnostids seems to be the way in which the segments overlap one another, and, it must be confessed, this seems a fundamental feature. It is, however, possible to conceive that the ordinary mode of progression of the agnostids was backward and that this direction of locomotion led to the similar development of the two shields and the change in the overlapping of the segments. It will be noted that nowhere in the Agnostidae do we see a nuchal spine developed, this being an impossibility for the cephalon, since the first segment laps over the neck-ring, and although such a spine might develop on the front of the pygidium, it would hardly be expected.

The preponderance of the evidence seems to be, then, in favor of returning to the view of Wahlenberg and other early writers, and orienting the agnostids in a position which is exactly the reverse of the one at present in general vogue.

Since the above was written, the writer has described *Agnostus insuetus* (Proc. Boston soc. nat. hist., 1924, **37**, p. 393, pl. 12, fig. 2). When placed in proper light under a binocular microscope, the specimen appears to show traces of facial sutures meeting at the front on the dorsal side of the shield bearing the marginal spines, and usually designated as the pygidium.

Arthrorhachinae Raymond.

Arthrorhachis galba (Billings).

Agnostus galba Billings, Pal. foss. Canada, 1865, **1**, p. 297, fig. 288. Vogdes, Amer. geol., 1892, **9**, p. 395, pl. 9, fig. 6. Bassler, Bull. 2a, Geol. surv. Virginia, 1909, p. 111, fig. 10, 2–5 (from Billings).

The short glabella and short axial lobe of the pygidium make this a typical Arthrorhachis, very similar to the type of the genus.

Measurements: — Billings says of his specimens: "Length of head and pygidium from 1 to 2 lines each" [2 to 4 mm. approximately].

The type (measurements of the figure, not the specimen) has the following dimensions: — Cephalon 3.75 mm. long, 4 mm. wide; glabella 2.25 mm. long, 2 mm. wide at base; pygidium 3.5 mm. long, 4 mm. wide; axial lobe 2.25 mm. long, 1.5 mm. wide at middle.

Horizon and Locality: — Billings's specimens were all from Newfoundland, and the horizons cited are M and N at Table Head and Pistolet Bay and P, four miles northeast of Portland Creek. Professors Schuchert and Twenhofel collected typical specimens in zones M_2 and N_1 and in the Isolated limestone, all at Table Head, Nfld. Schuchert and Dunbar obtained one pygidium from the Cow Head conglomerate at Cow Head, Nfld. Bassler has reported the species from the Liberty Hall limestone at Lexington, Va., and from the Thomas farm, three miles northeast of Blacksburg, Va., where it is very abundant at the top of the Holston.

I did not find any agnostid at Lexington, but obtained many from the Thomas farm. These latter differ in some minor respects from those found in Newfoundland, and are, I believe, to be regarded as a new species.

Arthrorhachis longicollis, sp. nov.

Plate **1**, fig. 5, 6.

Associated with *Arthrorhachis galba* in Newfoundland, Schuchert and Twenhofel found a few specimens which apparently represent two other species of the same genus. One only of these species is represented by cephala, whereas there are two kinds of pygidia, which makes it impossible to be absolutely sure of the allocation of the abdominal shields.

In *A. longicollis* the form of the cephalon and the arrangement of glabellar furrows and median pustule is the same as in *A. galba*, but the portion in front of the anterior cross-furrow is longer, which results in the elongation of the whole glabella. The pygidium which seems to belong to this cephalon is similar to that of *A. galba*, but has a small median tubercle at the posterior end of the axial lobe. An exfoliated specimen shows also dark markings which indicate four pairs of faintly impressed furrows at the sides of the axial lobe. A specimen with the test shows three pairs of very shallow lateral furrows. Both have a narrow longitudinal median line. The surface is minutely reticulated.

That this is the pygidium which probably belongs with the above cephalon is indicated by the fact that this type of cephalon and

pygidium are associated both in the Isolated limestone and in M at Table Head, Nfld., whereas the pygidium next described is found only in the Isolated limestone.

Measurements: — Cephalon 2.5 mm. long, 2.75 mm. wide; glabella 1.75 mm. long, 1.5 mm. wide; pygidium 3 mm. long, about 3 mm. wide (imperfect); the axial lobe is 1.75 mm. long.

Horizon and Locality: — A cephalon from the Isolated limestone at Table Head is designated as the holotype. A pygidium from M_2 at Table Head is figured as a paratype. Known only from these two occurrences in the Normanskill of Newfoundland. Types in the Yale University Museum.

Arthrorhachis, sp. ind.

A third species of Arthrorhachis is indicated by pygidia with an axial lobe which bears a small pustule about midway. Behind the pustule are a pair of shallow grooves running down into the dorsal furrows and outlining the posterior portion of the axial lobe.

Measurements: — The best pygidium is 4 mm. long, and 4 mm. broad. The axial lobe is 2.5 mm. long, and 1.75 mm. wide at the middle.

Horizon and Locality: — Pygidia of this species have been found in the very fossiliferous fault-block at Table Head, Nfld., associated with other typical Normanskill fossils.

Arthrorhachis elspethi, sp. nov.

Plate 1, fig. 2–4.

This trilobite is very closely allied to *A. galba*, having the same form and disposition of lobes and furrows, but differs in having a shorter, more pointed glabella, and shallower furrows. A comparison with Billings's figure of *A. galba* would lead one to suppose the outlines of the cephala to be very different, since *A. elspethi* has a pair of marginal spines, but closer inspection shows that specimens from Newfoundland have these same projections. The pygidium of the new species is almost identical with that of *A. galba*. The axial lobe normally appears smooth, but well-preserved specimens when inspected in the proper light, show a pair of incomplete furrows and a very faint median tubercle. It has been necessary to greatly exaggerate these to show them in the figure.

Measurements: — The specimens from the Thomas farm near

Blacksburg have the following proportions: — Cephalon 3 mm. long, 3 mm. wide; glabella 1.25 mm. long, 1.25 mm. wide at base; pygidium 3.5 mm. long, 3.75 mm. wide; axial lobe 2 mm. long, 1.75 mm. wide at the middle.

Horizon and Locality: — This species is abundant in the highest strata of the Holston limestone on the Thomas farm, three miles northeast of Blacksburg, Va.; six specimens have been found in a limestone near the middle of the Athens, in a railroad cutting one mile south of Otes, north of Bullsgap, Tenn., and three in the Athens two miles north of Athens, Tenn. The cotypes (M. C. Z. 1,626, 1,627) are from the Thomas farm.

Condylopyginae Raymond.

Peronopsis munda, sp. nov.

Plate 1, fig. 7.

Cephalon and thorax unknown.

Pygidium narrow, subquadrate, highly vaulted, surrounded by a narrow convex border. Axial lobe narrow, very convex, crossed by a single transverse furrow. In front of the furrow there is an ill-defined elevation suggestive of a large median pustule. Pleural lobes narrow, convex, and smooth. The accessory lobes at the anterior end of the axial lobe are very small.

The narrow pygidium of this species suggests that of *P. integer* (Barrande), the type of the genus. It differs from that species, however, in lacking radiating grooves diverging from the dorsal furrows. *P. bidens* (Meek), an Upper Cambrian species from Nevada, has the transverse furrow much farther forward. *P. sidenbladhi*, which occurs with the Ceratopyge fauna in Europe, has the transverse furrow arched backward, instead of straight, and the Peronopsis which I listed from the Shumardia limestone at Levis as *P. sidenbladhi* also has a curved transverse furrow.

Measurements: — Length of pygidium 2.25 mm., greatest width 1.75 mm.; length of axial lobe 1.5 mm.; distance from anterior border to transverse furrow 1 mm.

Horizon and Locality: — The holotype (M. C. Z. 1,726) was collected from the Lower Ordovician in the Sinclair Canyon near Lake Windermere, southeast of Golden, B.C., by Dr. Francis P. Shepard.

Harpedidae Corda.

Eoharpes uniserialis, sp. nov.

Plate 1, fig. 8, 9.

Cephalon high, with steep sides, narrow, deeply concave brim and long slender genal spines. Glabella high and wide, with strongly developed basal lobes and a wide deep circumglabellar furrow, which, opposite the basal lobes, is expanded into deep semicircular "alar" depressions. The simple eyes are situated on low mounds on the highest points of the cheeks, and are connected to the glabella by short eye-lines. The sides of the cheeks are very steep, descending without the intervention of a cheek-roll into the narrow concave brim. The genal spines are longer than the central part of the cephalon, and at their posterior ends turn rather sharply inward. Along the deepest part of the brim is a single line of large pits, around which smaller pits are scattered irregularly. The sides and front of the cheeks are covered with large pits which are rather regularly arranged, though not in perfect alignment, and the top of the cheeks outside the circumglabellar furrow, has somewhat smaller ones. The glabella and the alar areas are smooth.

Thorax and pygidium unknown.

Measurements: — The most perfect cephalon is 8 mm. long on the median line, and 22 mm. long from the front to the tip of the genal spines. It is 14.5 mm. wide at the neck-ring. The glabella is 5.5 mm. long, and 5 mm. wide across the basal lobes. The brim is 1.5 mm. wide at the sides. A larger specimen is 32 mm. long over all, 11.5 mm. long on the median line, and 21 mm. wide at the neck-ring.

Among the described species of Eoharpes from the American Middle Ordovician, only *E. dentoni* (Billings) and *E. rutrellum* (Clarke) have as narrow a brim as *E. uniserialis*. *E. dentoni* is readily distinguished because the glabella has a reticulate ornamentation. *E. rutrellum* is a much more closely allied species, differing chiefly in having a much broader cephalon, and in having the glabella covered with shallow pits instead of being smooth.

Horizon and Locality: — From the Kimmswick limestone at Mincke, St. Louis Co., Mo., where the types (M. C. Z. 1,681, 1,682) were collected by Dr. D. C. Barton.

Eoharpes fragilis, sp. nov.

Plate 1, fig. 10, 11.

Cephalon broad, depressed, with a broad slightly concave brim which is extended into short genal spines. The glabella is narrow, with a distinct neck-furrow and two pairs of faintly defined lateral furrows. The alar areas are scarcely outlined and the cheeks slope gently on all sides into the brim. Near the base of the slope there is a slight constriction and a suggestion of a cheek-roll. The simple eyes are rather large, situated a little back of the anterior end of the glabella, with which they are connected by faint eye-lines. The surface of the glabella and cheeks is smooth, the cheek-roll is faintly pitted, and the brim is covered with very small pits and very faint radiating lines.

This species differs from *Eoharpes antiquatus* in having a wider brim, smoother surface, less conspicuous eye-lines, and in many other minor features.

Eoharpes granti (Billings) is the most closely allied species, but it differs from that form in the presence of a faint cheek-roll, in having much less conspicuous radial markings on the brim, and in having the ocelli a little farther back.

Measurements: — A cranidium is 15 mm. long, and 16 mm. broad at the neck-ring. The brim is 4.5 mm. wide at the front.

Horizon and Locality: — Five fragmentary cephala were collected by Professor Dunbar from a pebble in the Cow Head conglomerate on Stearing Island, Nfld. The associated fossils were *Hadrohybus dunbari*, *Homotelus cataetus*, and *Pliomerops barrandei*. The types are in the Yale University Museum.

Eoharpes granti (Billings).

Harpes granti Billings, Pal. foss. Canada, 1865, 1, p. 326, fig. 314.

A single cranidium which seems to be referable to this species was obtained from the Cow Head conglomerate in Newfoundland.

The important characteristics of the species appear to be the presence of two pairs of glabellar furrows, lack of distinct alar areas at the base of the glabella, and presence of strongly developed radial markings on the brim. The central part of the cephalon is raised high above the brim, the slopes are steep and there is no cheek-roll.

Measurements: — Length of cephalon, including spines, about

35 mm., length on the median line about 15 mm., greatest width 29 mm. Length of glabella 6.5 mm., width at base, 6 mm.

Horizon and Locality: — Billings's original specimen was found in a conglomerate on lot 20, range 6 of Stanbridge, Quebec. The specimen from Newfoundland was from a pebble in the Cow Head conglomerate, at the Lower Head, Nfld., and was collected by Professors Dunbar and Schuchert.

Eoharpes, spp. ind.

The presence of Eoharpes in Virginia is attested by fragments of the brim found near the top of the Holston at the Thomas farm, three miles northeast of Blacksburg, and in the Ottosee at and two miles east of Fugates Hill and seven miles north of Mendota, Va. These fragments are too small for specific identification, but suggest a species with a narrow brim, like *Eoharpes antiquatus* (Billings).

Dr. Bassler (Bull. 2a, Geol. surv. Virginia, 1909, p. 111, fig. 1) has reported *Eoharpes ottawaensis* (Billings) from the Liberty Hall at Lexington, Va., but as the specimens are fragmentary it may turn out that they are not conspecific with the Chazy and Trenton form.

In the upper, more thinly bedded, portion of the Holston in the railroad cutting west of the Ross Republic quarry, southeast of Knoxville, Tenn., I found a nearly complete cephalon of an Eoharpes, which because it lacks the brim is not capable of exact identification or description. The glabella is badly worn, but was evidently high and rather broad, with the usual basal lobes and the rounded smooth alar areas near its posterior end. Neither eye-lines nor ocelli are visible, which may, however, be due to poor preservation. The genal spines were apparently of about the same length as those of *E. antiquatus*. In size, this specimen is about the same as the examples of *E. ottawaensis* found in the Chazy of the Champlain Valley, and considerably larger than the average specimen of *E. antiquatus*.

Harpes telleri Weller.

Plate **6**, fig. 6.

Harpes telleri Weller, Bull. 4, Chicago acad. sci., 1907, p. 213, pl. 20, fig. 2.

This is a form which I should have noticed in my article on the trilobites of the Silurian of Wisconsin, but the specimen was overlooked.

Harpes telleri is exceedingly rare, and the slab here figured, from the

Day collection in the M. C. Z., contains the only recorded examples other than those in Mr. Teller's possession. Being preserved so as to show the under side, they present a few points of interest not exhibited by the type.

The two specimens show different states of preservation. The smaller is the more perfect, since it retains the free cheeks (or ventral plate), and it will be noted that this makes a great difference in the appearance. The ventral plate is somewhat broader than the dorsal brim, and has attached to it a vertical band which closes the opening between the ventral plate and the brim. This vertical band extends somewhat below the ventral plate, so that it shows as a narrow rim on the lower side of the smaller specimen figured. Weller commented upon the deep furrow which bounded the inner margin of the brim of the type, and since that specimen appears to be a cast of the interior, it is probable that the deep furrow is an impression of the lower edge of the vertical plate.

Harpes telleri is one of the forms with what Dr. Bather has called a cheek-roll, and the upper edge of the roll is outlined by a furrow, concentric with the inner margin, but situated part way up the slope of the glabellar mound and not far in front of the eyes. This is shown on the interior of the larger specimen figured, and it is of interest to see that this furrow coincides with the position of the upper edge of the vertical plate. This plate is then a partition which shuts off the anterior part of the cephalon from the area occupied by the vital organs, and its presence explains the cheek-roll.

Another feature shown by these specimens is the upward twist of the inner margin of the genal spines some distance in front of the ends. This twist turns the genal spines upward so that the ventral surface is not flat and the upper inner margin forms a gradual slope to the neck-segment. This twist is present in many species of Harpes, but is not seen, because one seldom has the specimens exposed from the ventral side.

Horizon and Locality: — The species has so far been found only in the Silurian in the vicinity of Milwaukee. The specimens (M. C. Z. 1,624, 1,625) in the Day collection are from Wauwatosa, Wis.

Harpides concentricus Billings.

Harpides concentricus Billings, Pal. foss. Canada, 1865, **1**, p. 282, fig. 268.

This species remains practically unknown, but it may be worth recording that Professors Schuchert and Twenhofel found a small

fragment of a brim in the fault block of the Normanskill at Table Head, Nfld. Billings's specimens were from the conglomerates of division P, northeast of Portland Creek, Nfld.

Trinucleidae Emmrich.

Since my previous discussion of the subdivisions of the Trinucleidae seems to have been overlooked or misunderstood, I will repeat here the reasons for using the names Tretaspis, Trinucleus, and Cryptolithus, as I did in the Zittel-Eastman Textbook of Palaeontology.

Starting from two premises, which probably do not need further demonstration, namely, that the name Cryptolithus antedates Trinucleus and that the Trinucleidae are capable of subdivision, I endeavored to save Trinucleus as a generic name.

Murchison, under the caption of Trinucleus, described six species. The fifth of these, *Trinucleus nudus*, is an Ampyx, the sixth, *T.? asaphoides*, was referred by Salter to *Ogygiocaris buchii*, and the first and fourth, *T. caractaci* and *T. lloydi*, belong to Cryptolithus. This leaves *T. fimbriatus* and *T. radiatus* in Trinucleus, and of these I chose *T. fimbriatus* as the type of the genus. Tretaspis forms an easily recognizable group, differing from Cryptolithus in the much more strongly developed glabellar furrows, the flask-shaped glabella, and the presence in the adult of simple eyes and eye-lines. Trinucleus, as restricted, shows the same flask-shaped glabella and glabellar furrows as in Tretaspis, but lacks the simple eyes and eye-lines of that genus, and also has the fringe marked by pits in prominent radial grooves, instead being arranged in concentric lines as in Tretaspis and Cryptolithus. More recently (Amer. journ. sci., 1917, ser. 4, **43**, p. 204), I have suggested another genus, Trinucleoides, to include the primitive *T. reussi* of Barrande, which has an exceedingly simple fringe and an elongate spine on the glabella.

Trinucleoides Raymond. Fringe narrow, with only one row of large pits. Glabellar furrows so modified as to isolate a pair of large lateral lobes. Glabella with long erect median spine. Simple eyes absent. Type: — *Trinucleus reussi* Barrande. Lower Ordovician, Bohemia.

Tretaspis McCoy. Fringe marked by concentric rows of pits. Glabella flask shaped, with three pairs of furrows. Simple eyes present. Type: — *Asaphus seticornis* Hisinger. Lower, Middle, and Upper Ordovician, cosmopolitan.

Trinucleus Murchison. Fringe marked by pits in radial furrows.

Glabella flask shaped, with three pairs of furrows. Simple eyes absent. Type: — *Trinucleus fimbriatus* Murchison. Middle Ordovician, Scandinavia, Great Britain, and eastern North America.

Cryptolithus Green. Fringe marked by pits in concentric rows. Glabella obovate, furrows indicated only by faint indentations or spots. Simple eyes absent in the adult. Type: — *Cryptolithus tessellatus* Green. Middle and Upper Ordovician, cosmopolitan.

Trinucleus acervulosus Raymond.

Plate **1**, fig. 18.

Trinucleus acervulosus Raymond, Bull. M. C. Z., 1920, **64**, p. 273.

Entire test flattened, subcircular in outline, twice as wide as long, with a narrow fringe. Glabella flask shaped, narrow, bulbous in front, constricted to a narrow, low neck behind. There are three pairs of glabellar furrows besides the neck-furrow, two pairs showing as deep pits in the neck and one pair as small pits at the sides back of the middle of the bulb. On the middle of the bulb is a small tubercle. Fixed cheeks evenly convex, without eye-lines or eyes in all specimens seen. One specimen shows traces of genal caeca running out nearly to the genal angle. Surface of glabella and cheeks reticulate. Fringe narrow, marked by radiating grooves separated by rounded ridges of about the same width. In the bottom of each groove are two pits, the anterior of which is the larger. At the genal angles the fringe widens and is marked by a number of irregularly placed, small pits. No specimen has been seen which retains genal spines, but they were undoubtedly present, as there is a long spine on one of the slabs.

Thorax of six narrow segments of the usual form in the family.

Pygidium a little more than twice as wide as long, somewhat angular in outline on the posterior margin, nearly flat, with an abruptly deflected smooth border. Axial lobe narrow, not strongly elevated, with twelve to fifteen narrow rings separated by narrow, sharp furrows. Pleural lobes flat, with eight or nine pairs of ribs, each bearing a broad deep furrow.

Measurements: — The holotype (M. C. Z. 1,592) is 19 mm. long, 19 mm. wide at the genal angles; the cephalon 8 mm. long; thorax 5, and pygidium 6 mm. long. The bulb of the glabella is 5 mm. wide; the axial lobe of thorax 3 mm. wide; the pygidium 13 mm. wide. The fringe is 1 mm. wide, and there are twelve grooves in 5 mm. Another

specimen is 19 mm. long, and 18 mm. wide, and a third 12.5 mm. long, and 12 mm. wide.

This species, the first American representative of the genus to be known from complete specimens, is more like *Trinucleus diademata* (Ruedemann) than any other allied form. Ruedemann's species from the boulders at Rysedorph Hill was described from an incomplete cephalon, so that detailed comparison is not possible. It would appear, however, that *T. acervulosus* has a narrower fringe and less prominent glabella than specimens from the New York.

Trinucleus fimbriatus Murchison, the type of the genus as restricted, is very similar to *T. acervulosus*, but differs in having more pits in the fringe, particularly at the genal angles. *T. fimbriatus* and *T. acervulosus* are probably from about the same horizon (Llandeilo).

Formation and Locality: — Numerous specimens of this species have been collected by Prof. Roy Holden from the Athens shale three miles northeast of Blacksburg, Va. I have found fragments which appear to belong to this species in the Athens two miles north of Athens, Tenn.

Cryptolithus, sp. ind.

A single fragment of the cheek and fringe of a small specimen indicates the presence of this genus in the Athens in the Catawba Valley. The cheek is smooth, and the fringe shows three rows of small pits, concentrically arranged. Repeated searches in this locality have failed to reveal additional specimens, but this is sufficient to demonstrate the presence of the genus in the Athens.

Dionidеidae Raymond.

Dionidеidae Raymond, Bull. M. C. Z., 1920, **64**, p. 274.
Dionideae Gürich, Centrabl. min. geol. pal., 1907, p. 135 (*nomen nudum*).

Dionide has usually been placed with Trinucleus and Ampyx in the Trinucleidae. The structure is, however, not in accord with either of those genera and since they have been separated, Dionide can not logically be placed in either family. The free cheeks are ventral like those of the Trinucleidae, but the cephalon does not have a regularly pitted brim and the pygidium is very large. The family may be diagnosed as follows: —

Isopygous hypoparia with six segments in the thorax and both shields large. Free cheeks ventral except for the genal spines. Sur-

face of cephalon irregularly pitted. Hypostoma short, rounded, tuberculated.

One genus, Dionide Barrande. Ordovician, Europe and North America.

Dionide Barrande.

Dione Barrande (*non* Dione Hübner 1816), Not. prelim., 1846, p. 32.
Dionide Barrande, Neues jahrb., 1847, **4**, p. 391.
Polytomurus Corda, Prodrom einer mon., 1847, p. 37.

Although known to have a fair specific representation in the British Isles, and to be represented by a single species in Sweden and Bohemia, this strictly Ordovician genus was first reported from America in 1920. To differentiate satisfactorily the similar Endymionia, it became necessary to restudy the typical species, *Dionide formosa* Barrande, of which the M. C. Z. fortunately possessed a considerable number of specimens. Careful study indicates the presence of four, rather than one species in Bohemia, and those will be reviewed in connection with the ones discovered by Professor Holden in Virginia.

Dionide formosa Barrande.

Dione formosa Barrande, Not. prelim., 1846, p. 32.
Dionide formosa Barrande, Neues jahrb., 1847, **4**, p. 391.
Polytomurus formosus Corda, Prodrom einer mon., 1847, p. 37, pl. 3, fig. 16.
Dionide formosa Barrande, Syst. Silur. Bohême, 1852, **1**, p. 641, pl. 42, fig. 24, 28 (*non* 25, 27).

This species, as exemplified by the large complete specimens with long genal spines is too well known to require a formal description, but it should be restricted to the forms with subtriangular pygidia which have 20–25 rings on the axial lobe, and about sixteen pairs of ribs on the pleural lobes. The furrows separating the rings on the axial lobe are narrow and very deep, and their course is doubly bowed, being convex forward at the center, and concave forward at the sides. The cephalon presents few distinctive characteristics. The glabella appears to be somewhat less swollen than that of the other Bohemian species, and has the glabellar furrows but not the spine, of the adult *D. speciosa*. The nervures originate farther forward in this species than in either *D. jubata* or *D. speciosa* and the long flat genal spines of the free cheeks are of course characteristic.

It will assist in distinguishing among three of the Bohemian species to point out that in *D. formosa* the pygidium is longer than the

cephalon, in *D. speciosa* the shields are equal in length, and in *D. jubata* the pygidium is shorter than the cephalon.

Measurements: — One specimen is about 29 mm. long, and 24.5 mm. wide; the cephalon is 9.5 mm. long; the thorax 9.5 mm.; and the pygidium 11 mm. Another is 16.5 mm. long, 16 mm. wide; cephalon 5.5 mm. long; thorax 5.5 mm.; and pygidium 6 mm. long.

Horizon and Locality: — This species is represented in the Schary collection by specimens from Wince, Trubin, and Hredle, near Zebrak, Bohemia. All these from stage D–d_3.

Dionide speciosa (Corda).

Polytomurus speciosus Corda, Prodrom einer mon., 1847, p. 37.

Dionide formosa Barrande (*pars*), Syst. Silur. Bohême, 1852, **1**, pl. 42, fig. 25–27 (*non* 24, 28).

Dionide formosa Barrande, Syst. Silur. Bohême Suppl., 1872, p. 50, pl. 1, fig. 18a, b.

Dionide formosa Novak, Beitr. pal. österreich-ungarns u. orients, 1883, p. 30, pl. 8, fig. 17a, b.

Specimens small for the genus, oval in outline, the breadth at the back of the cephalon nearly equal to the length. The cephalon and pygidium are equal in length and the thorax is slightly shorter than either shield.

The cephalon is two and one half times wider than long, regularly rounded in outline, with the genal angles extended into spines which in the adult reach back as far as the posterior end of the pygidium; in young specimens 6 mm. long, the spines extend as far back as those of *D. formosa*, *i.c.*, to a distance beyond the end of the pygidium equal to about three fourths the length of the body. The cranidium makes up nearly the entire cephalon, the free cheeks appearing on the dorsal surface only in the genal spines, as usual in the genus. The glabella is raised high above the fixed cheeks, and separated from them by a narrow circumglabellar furrow. About half-way to the front of the head is a short lateral glabellar furrow on either side, and at the back there are two deep narrow furrows which run straight forward from the neck-furrow. Almost exactly in the middle of the top of the glabella there is a small pustule, and directly back of it and close to it, the base of a considerably larger spine. Otherwise the surface of the glabella is smooth.

The fixed cheeks are convex, the surface finely reticulated with small pits and on each side two or three branching genal caeca extend from

the dorsal furrows across the cheeks to the neighborhood of the genal angles. There is a very narrow smooth border around the anterior and lateral margins of the cephalon, and just within it a row of small but deep pits. The neck-furrow is narrow but clear cut, and the neck-ring narrow and smooth.

Young specimens differ from the adult in having a cross-furrow on the glabella, connecting the anterior ends of the posterior glabellar furrows, and showing a pair of curved pits ahead of these, indicating the position of the next pair of furrows. Some specimens showing these glabellar furrows have three and others six thoracic segments and the length is from 3.5 to 6 mm.

The hypostoma has been figured by Barrande. It is large, covering practically the whole of the region below the glabella. The surface is gently convex, the oval body separated by a furrow from the large wings. On the body are a number of low rounded pustules.

The thorax consists of six segments, the first of which is broader and more strongly marked than the succeeding ones. The axial lobe is narrow, convex, the pleural lobes flat on top, deflected toward the outer ends of the segments. On the pleural portions of the first segment the furrows are diagonal, rather wide, and deeply impressed, but on the posterior ones they are narrow and more nearly parallel to the anterior edge of the segment. On the axial lobe also there are diagonal grooves on each ring, which cut off small triangular areas near the dorsal furrows.

The pygidium is nearly semicircular, being almost twice as wide as long. The axial lobe is narrow, convex, and has from 10–15 rings, which are especially closely crowded together at the posterior end. The pleural lobes have from 10–12 pairs of ribs, each with a broad diagonal furrow which is more conspicuous than the very narrow horizontal grooves between them. All furrows extend out to the very edge of the pygidium.

Measurements: — One specimen is 11.5 mm. long, and 10 mm. wide; the cephalon is 4 mm. long; thorax 3.5 mm. long; and pygidium 4 mm. long. Another is 18 mm. long, and 15 mm. wide; the cephalon is 6.5 mm. long; thorax 5.5 mm.; and pygidium 6 mm. long.

Corda pointed out two of the salient characteristics of this species in his original description, namely, the rounded pygidium and the relatively small number of rings on the axial lobe of that shield. Barrande, however, preferred to consider it a wide form of *D. formosa,* but evidently was not struck by the fact that all the specimens of the long form occurred in zone $D-d_3$, and all the wide ones in $D-d_5$.

Corda was not quite correct in stating that the rings of the axial lobe do not cross the middle, though the bounding grooves are decidedly weaker there, and there are conspicuous pits in the furrows on either side of the median line. The bowing of these furrows is not nearly as prominent as in *D. formosa*.

The most characteristic feature of the cephalon is the presence of a large spine on the glabella, back of the median pustule. The actual spine has not been seen, but the large base, which always presents a fractured surface, is sufficient evidence of its presence. Corda indicated a long spine on his figure of *D. formosa*, but placed it on the median tubercle, and not in the position of the spine of *D. speciosa*.

The presence of the glabellar spine and the rounded pygidium with relatively few rings and ribs distinguish this species from *D. formosa*. To *D. jubata* it is much more closely allied, differing from it principally by the presence of the glabellar spine.

Horizon and Locality: — All the specimens in the Schary collection are from stage D—d_5, the highest zone of the Ordovician in Bohemia, and with one exception, they are from Leiskow, near Malkow. The other specimen is a large one from Mount Kosov. Corda stated that his specimens came from near Beraun, which is some distance northeast of Leiskow, and Novak recorded it (under the name of *D. formosa*) from Leiskow, as did Barrande under the same name in the Supplement.

Dionide jubata, sp. nov.

Plate 1, fig. 12, 13.

Specimens small for the genus, oval to subcircular in outline, about as broad as long. The cephalon is slightly longer than the pygidium, and the thorax slightly shorter than either shield, the proportions being about as 11: 8: 10.

The cephalon is about two and one half times as wide as long, the broad bulbous glabella standing high above the rather flat cheeks. The glabella shows no lateral glabellar furrows, but two furrows running directly forward from the neck-furrow make small indentations at the back. Several specimens show a rather faint forward prolongation of these furrows, producing a broad median ridge, but whether this is natural or the result of pressure can not be satisfactorily determined. Some show a trace of lateral furrows in the sudden broadening of the anterior portion of the glabella. The median pustule is rather prominent on the otherwise smooth surface, and back of it there is a small bulge, which when broken or distorted, suggests

the spine-base of *D. speciosa*. The cheeks are entirely covered with irregularly arranged pits and are crossed by the branching genal caeca. Long genal spines represent the free cheeks. These spines are not complete in any specimens studied, but evidently extended far back. Anterior border and neck-ring narrow and smooth, the border being an elevated wire-like rim.

Thorax of six segments, and apparently in all respects like that of *D. speciosa*, except that the first segment is a little less conspicuously different from the remaining ones.

Pygidium semicircular, twice as wide as long, with 10–12 rings on the axial and 8–10 pairs of ribs on the pleural lobes. The grooves between the segments are so faintly marked, and the diagonal furrows on them so deep, that the ribs are structurally made up of halves of adjacent segments, rather than from segments. This same fact is true of most other trilobites, but not so obviously as in this form.

Measurements: — One specimen is 14 mm. long and has the same width; the cephalon is 5.5 mm. long; the thorax 4 mm., and the width 5 mm. Another has a cephalon 4 mm. long; pygidium 3.5 mm. long.

This species is readily distinguished from *D. formosa* by its small size and its very short rounded pygidium with few rings and ribs. It is more like *D. speciosa*, but the glabella lacks the spine of that species, and the pygidium is shorter and the ribs more rounded, with less prominent furrows.

Horizon and Locality: — All the specimens in the Schary collection are from stage D—d_1, at Saint Benigna, Bohemia. The cotypes are M. C. Z. 1,629, 1,630.

Dionide prima Klouček.

Dionide prima Klouček, Bull. int. Acad. sci. Bohême, 1917, **21**, p. 10.

This species has been but briefly described, and not yet figured. It is said to differ from *D. formosa* Barrande of zones $Dd_1\gamma\beta$ and higher, in lacking the longitudinal furrows which divide the posterior part of the glabella into three lobes. These furrows are constant features of *D. formosa*, *D. speciosa*, and *D. jubata*. The species is reported only from the lowest fossiliferous zone of D, $Dd_1\gamma\alpha$.

Dionide, sp. ind.

Dionide formosa Zelizko, Bull. int. Acad. sci. Bohême, 1907, **11**, pl. 1, fig. 6.

I have not seen this species, but if the published figure is to be relied upon, the anterior position of the median tubercle and the size

and form of the cephalon prevent its reference to any described species. The cephalon is somewhat distorted, but even making allowance for that, the length is greater in proportion to the width than in *D. formosa*. The cephalon is much larger than that of any specimens of *D. speciosa* or *D. jubata* so far seen.

Horizon and Locality: — Zelizko refers the fauna from near Rozmital, Bohemia, with which this specimen occurred, to the lower Ordovician, $D-d_1$.

Dionide holdoni Raymond.

Plate 1, fig. 16, 17.

Dionide holdoni Raymond, Bull. M. C. Z., 1920, **64**, p. 274.

Animal of medium size for the genus; test oval in outline, about one fifth longer than wide.

Cephalon short, about three times as broad as long. Glabella relatively short, reaching only two thirds the length of the cephalon, moderately convex, smooth except for the small median tubercle and a larger spine-base back of it. At the sides of the glabella there are faint indentations of a pair of lateral furrows, and at the back a pair of short longitudinal ones. These latter are somewhat longer in young specimens than in the adults. Fixed cheeks depressed convex, covered with a fine network of irregular radiating branching ridges and small shallow pits. The two principal genal caeca originate on either side of the glabella just in front of the lateral furrows and run diagonally backward, reaching the neck-furrow some distance inside the genal angles. Those on the right cheek of one specimen not only branch, but in the outer part of their course, the two unite, showing conclusively that they are not facial sutures. The cephalon has a narrow, upturned rim around its border, and in the concentric depression within this is a row of pits which are larger and deeper than the others on the cephalon. The neck-furrow is linear, clearly impressed, and the neck-segment smooth. As usual in the genus, the facial suture is marginal except at the genal angles, where it cuts off the spines. These latter are not satisfactorily preserved on any specimens, but apparently were not long enough to reach beyond the third thoracic segment, a very unusual feature in this genus, and leading one to suspect that the specimens are incomplete in this regard.

Thorax with six narrow segments, the first of which is a little wider than the succeeding ones but not differently marked. Axial lobe narrow, each ring showing the diagonal furrow at the sides as is usual

in the genus. The furrows on the pleural lobes divide each lateral portion of a segment into an anterior area which is pitted like the fixed cheeks, and a narrower smooth posterior part.

The pygidium is about twice as wide as long, rounded in outline, with, in some cases, sufficient straightness of sides to produce a slight triangularity. Axial lobe narrow, with about fifteen rings, and pleural lobes with about twelve pairs of furrowed ribs which extend to the edge. Surface pitted, like that of fixed cheeks.

Measurements: — One specimen is 15.5 mm. long, 13 mm.; wide at the genal angles. The pygidium is 5.5 mm. long, 11.5 mm. wide; thorax 4.5 mm. long; cephalon, 5.5 mm. long. Another specimen is 15 mm. long, and 12.5 mm. wide. A third specimen is 19.5 mm. long, and 15 mm. wide.

A cephalon is 6 mm. long, and 18 mm. wide; distance from back to front of glabella, 4 mm., width of glabella 4.5 mm.

This species is more like *Dionide richardsoni* Reed than any other known species of the genus. The likeness is emphasized particularly by the ornamentation of the thorax. It has, however, fewer rings and ribs on the pygidium, a wider cephalon, and narrower axial lobe. The ornamentation of the thorax and pygidium separates it from all other species.

Horizon and Locality: — This species has so far been found only at a locality about 100 feet below the top of the Athens shale about three miles northeast of Blacksburg, Va., where it was collected by Professor Holden, for whom it is named. The associated fossils are typical Normanskill graptolites, brachiopods, and trilobites. Holotype (M. C. Z. 1,590); paratype (M. C. Z. 1,720).

Dionide contrita Raymond.

Plate 6, fig. 9.

Dionide contrita Raymond, Bull. M. C. Z., 1920, **64**, p. 276.

This species is represented by only a single specimen, a rather poor pygidium to which are attached parts of two segments of the thorax. It would not be worthy of description were it not for the fact that it belongs to the group with large pygidia.

Cephalon not yet known.

Thorax with narrow axial lobe and short segments, the outer ends of which turn backward.

Pygidium large, nearly semicircular but not quite twice as wide as

long. Axial lobe narrow, tapering gradually and regularly. The last four millimeters of the axial lobe are broken off, but the anterior part shows eighteen rings, and there were apparently about twenty-four pairs of ribs on the pleural lobes, being especially crowded at the posterior end.

Measurements:—Length of pygidium, 14.5 mm., width about 24 mm. The axial lobe is 5 mm. wide at the front.

Horizon and Locality: — The only known specimen was collected by the writer about 100 feet above the bottom of the Athens shale near the Thomas farm three miles northeast of Blacksburg, Va. Holotype (M. C. Z. 1,591).

Raphiophoridae Angelin.

Before proceeding to describe the representatives of this family which are found in the Normanskill it will be serviceable to review briefly the characteristics of the genera.

Ampyx is of course the first founded and best known of them. The name was proposed by Dalman (Svenska vet.-akad. Handl., 1826, p. 252, 279) with the following description: —

"Oculi inconspicui, nec illorum loco prominentiae potius vero impressiones detegendae. Caput magnum triangulare, glabella magna prominente gibbaque, haud lobata.— Truncus brevis, segmentis paucis (6). Pygidium distinctum, integrum."

The only species described, which of course becomes the type, was *Ampyx nasutus*, and the figured specimen was an entire, enrolled one from the red limestone (Orthoceras limestone, *Megalaspis limbata* zone, of Beekmantown age).

There seems never to have been any doubt about the proper identification of Dalman's species, and figures which are in essential agreement are given by Angelin, Brögger, and Schmidt, among others. These descriptions and figures indicate that *Ampyx nasutus* is characterized by having an oval glabella which projects beyond the front of the cheeks and bears a spine which is directed forward and upward, and is circular in section. The free cheeks are rather large. The thorax has six segments, and the pygidium has smooth pleural lobes.

Raphiophorus was proposed by Angelin, at the time of the erection of the family (Pal. Scandinavica, 1854, **1**, p. 80), but the genus has never been looked upon with favor, though it has been used by Eichwald, Haupt, and Marr. Angelin separated it from Ampyx because the glabella was obovate instead of oval, and because there were five instead of six segments in the thorax.

The first species described by Angelin under the name Raphiophorus was *R. setirostris*, and as a complete specimen was figured, I propose that this species be designated the type of the genus.

Raphiophorus setirostris, as figured by Angelin has a large obovate glabella which extends considerably beyond the front of the cheeks and bears a long spine which is circular in section and appears to point straight forward. The thorax has five segments and the pygidium shows distinct ribs on the pleural lobes. The facial sutures are not indicated, but the free cheeks are probably about as large as in Ampyx. This species is said to come from Region Da (Chasmops strata, about Middle Trenton age) in Dalecarlia, and I have found no figure later than Angelin's.

Lonchodomas was proposed by Angelin at the same time as Raphiophorus, and the first species named was *Lonchodomas rostratus* (Sars). The specimen figured being complete, this may be taken as the type-species. Lonchodomas is clearly a distinct genus, the long prismatic spine into which the rather narrow glabella merges being entirely different from the glabellar spines of either Ampyx or Raphiophorus. There are five segments in the thorax, and in the type the pleural lobes of the pygidium have ribs.

These three were the only genera ascribed by Angelin to the Raphiophoridae, and it remains to decide whether or not Angelin was justified in separating Raphiophorus from Ampyx.

There are three principal ways in which Raphiophorus differs from Ampyx: — There are only five segments in the thorax, instead of six; the glabella is said by Angelin to be obovate instead of oval; and the pleural lobes of the pygidium have ribs instead of being smooth.

Looking over the more familiar literature, without tracing out every known species, I find that twenty species of Ampyx have been described from approximately entire specimens. Five of these have prismatic glabellar spines and so belong to Lonchodomas. They are: — *Ampyx tetragonus* Angelin, *Lonchodomas rostratus* (Sars), *Ampyx portlocki* Barrande, *Ampyx drummockensis* Reed, and *Ampyx macallumi* Salter. All of these have five segments in the thorax. Of the remaining fifteen species, five have six segments in the thorax, and ten have five segments. All of the ten species which have five segments in the thorax have ribs on the pleural lobes of the pygidium. These species are: — *Raphiophorus setirostris* Angelin, *R. scanicus* Angelin, *Ampyx ronaulti* Barrande, *A. tenellus* Barrande, *A. gratus* Barrande, *A. macconochieri* Etheridge and Nicholson, *A. parvulus* Forbes, *Raphiophorus aloniensis* Marr and Nicholson, *Ampyx volborthi* Schmidt, and *A. costatus* Sars and Boeck.

The species having six thoracic segments are: — *Ampyx nasutus* Dalman, *A. americanus* Vogdes and Safford, *A. incurvus* Reed, *A. nudus* (Murchison), and *A. salteri* Hicks. The pygidium of *Ampyx incurvus* is unknown, the pygidia of *A. nasutus* and *A. americanus* have smooth pleural lobes, the pygidium of *A. salteri* has only very faint ribs, but the pygidium of *A. nudus* is covered with very strongly marked elevated ribs. These data indicate, as to the association of number of segments with ribbed pygidia, that species with five segments in the thorax always have ribbed pygidia, and that species with six segments generally lack ribs, though they may sometimes have them.

From the constancy with which five segments in the thorax and ribbed pygidia are connected, it seems well worth while to retain the name Raphiophorus, but it must be admitted that other characteristics are wanting to enable an infallible separation of Raphiophorus and Ampyx. The shape of the glabella, cited by Angelin, as oval in Ampyx and obovate in Raphiophorus, although more or less useful, is not entirely dependable. A good example of this may be seen in Vogdes's (Amer. geol., 1893, **11**, p. 103) grouping of the species under Brevifrontes, glabella oval, and Longifrontes, glabella obovate. Under this classification, *Ampyx nasutus*, *Raphiophorus setirostris*, and *Lonchodomas portlocki* all fell into the same group, the Longifrontes.

Raphiophorus semicostatus (Billings).

Plate **1**, fig. 14, 15.

Ampyx semicostatus Billings, Pal. foss. Canada, 1865, **1**, p. 295, fig. 287.
Vogdes, Amer. geol., 1893, **11**, p. 108.

Billings knew only the pygidium of this species, which seems to be the most common member of the family in Newfoundland. There are several practically complete specimens in both the M. C. Z. and at Yale.

Whole trilobite broadly oval in outline, surface depressed, with the dorsal furrows converging nearly uniformly backward from the front of the cephalon to the end of the pygidium.

Cephalon nearly semicircular in outline, the glabella broad, expanding regularly to the place of greatest width, which is near the anterior end. Specimens which are not flattened show two pairs of furrows near the posterior end of the glabella, and a trace of a third pair. The glabellar spine is short, very slender, and circular in section. Fixed cheeks low, uniformly convex, and smooth. Free cheeks not seen, but evidently very narrow, if present at all on the dorsal surface.

Thorax of five segments, the axial lobe gently arched, the pleural lobes flat. The grooves on the pleura are straight furrows which expand toward the distal ends. Those on the first segment are bowed forward.

Pygidium short, with a sharply inclined striated border set at an angle of about 45° with the general surface. The axial lobe extends to the border and has four or five more or less distinct rings. The pleural lobes show three to four indistinct flat ribs which extend straight to the inclined border.

Measurements: — A large specimen is 10 mm. long, and 11 mm. wide at the back of the cephalon. The cephalon is 3.5 mm. long; the glabella 3.5 mm. wide. The thorax is 4 mm. long; and the axial lobe 2.5 mm. wide at the front. The pygidium is 2.5 mm. long, and 8 mm. wide. A small specimen is 8.5 mm. long, and 8 mm. wide. A still smaller one is 4 mm. long, and 4 mm. wide.

Horizon and Locality: — Specimens of this species from the Lingula shale on the east shore at Port au Port, and from the south side of St. Johns Island, Newfoundland, are in the M. C. Z. Schuchert and Twenhofel collected it from zones M_1 and N_2 at Table Head, Nfld, and zone 6 at Port au Port. It was also found by them to be especially abundant in the Isolated limestone at Table Head. Professors Schuchert and Dunbar collected a large number of complete specimens on the shore of Port au Port Bay, one mile from the Dominion Iron and Steel Quarries, at Agathuna. Many of these specimens are crushed in such a way that the anterior spine appears to be carinate.

Raphiophorus powelli Raymond.

Plate **2**, fig. 1, 2.

Raphiophorus powelli Raymond, Bull. M. C. Z., 1920, **64**, p. 276.

Entire test broadly oval, nearly as wide as long. Cranidium approximately semicircular in outline, the glabella projecting slightly in front of the cheeks. Glabella obovate, prominently convex, with a small spine directed forward and upward. At the base of the glabella there are two small narrow lobes, cut off by the posterior glabellar furrows. Fixed cheeks depressed convex. Free cheeks missing, but evidently narrow. Thorax with five segments, each pleuron bearing a deep linear, straight, median groove. Pygidium short and wide, with abruptly deflected posterior border. The pleural lobes bear two pairs of faintly defined ribs which curve backward to the margin.

Measurements: — Length 10.5 mm., width 9 mm. Length cephalon 5 mm., width 9 mm. Width glabella at front 3 mm., at back 2 mm. Length thorax 2.5 mm.; width axial lobe 2 mm. Length pygidium 2.5 mm. (*circa*), width 8 mm.

This species is very common at one horizon in the Athens in the Catawba Valley, north of Salem, Va., where Prof. S. L. Powell, for whom it was named, has collected many approximately entire specimens. The glabellar spine is, however, very rarely preserved, and usually it is impossible to detect any trace of its former presence. Two other curious characteristics were possessed by this trilobite. It sometimes grew to normal adult size without forming more than four segments, as seen in Plate **2**, fig. 2. In such cases the pygidium shows extra pairs of ribs. The presence of a pair of basal glabellar lobes is the other unusual feature, and one which suggests *Endymionia bellulata* Savage, the type of the newly established genus Ampyxina.

This species most nearly resembles *R. semicostatus*, differing only in having a less rapidly expanding glabella, in the presence of glabellar lobes, and in the pygidium, which has fewer and curved, instead of straight, ribs.

Horizon and Locality: — Aside from the typical region, the Catawba Valley, Va., I have found this species at Saltville, in the lower part of the Athens, and in yellowish calcareous shales near the railroad station at Bullsgap, Tenn. Holotype (M. C. Z. 1,598); paratype, (M. C. Z. 1,599).

Raphiophorus quadricostatus (Emmons).

Microdiscus quadricostatus Emmons, Amer. geology, 1855, **1**, p. 116, pl. 1, fig. 8. Man. geol., 1860, p. 88, fig. 73. Barrande, Bull. Soc. geol. France, 1861, ser. 2, **18**, p. 280, pl. 5, fig. 13. Marcou, Mem. Boston soc. nat. hist., 1888, **4**, p. 128.

Ampyx quadricostatus Bassler, Bull. 92, U. S. N. M., 1915, p. 42.

Emmons, in the second part of his American Geology, created for a small trilobite from Augusta County, Virginia, the new generic and specific names, *Microdiscus quadricostatus.* He stated that the specimen was found in "white fragile shales, associated with minute molluscas and graptolites."

The Athens (Liberty Hall) shales of Augusta County often weather to a grayish or greenish white, and after becoming acquainted with such trilobites as *Raphiophorus semicostatus* and *R. powelli*, one cannot doubt that *Microdiscus quadricostatus* is congeneric with them. Fortu-

nately Raphiophorus antedates Microdiscus, so that the latter name can be discarded. Dr. Bassler was the first to recognize that the original of Microdiscus was really an ampycid, but from the time of Barrande (cited above) various authors have had more or less doubts about the propriety of the continuance in use of the generic name. In 1912 I made a definite proposal to discontinue its use and to substitute Eodiscus, a name proposed by Matthew. Even since that time, however, Microdiscus has been in use for Lower and Middle Cambrian trilobites and it may interest some of those who now write Microdiscus Salter instead of Microdiscus Emmons, to read what Salter (Quart. journ. Geol. soc. London, 1864, **20**, p. 237) said on his first use of the term: — "Dr. Emmons described, from his Taconic strata*** a minute form, which, from its association with Graptolites and Mollusca, Barrande thinks may be the young state of *Trinucleus* or some such Lower Silurian genus. This is quite possible. But, at least, Emmons's figure is singularly like the small fossil here figured, and which Mr. Hicks finds abundant in the lower strata of the section at Porth-y-Rhaw. I do not feel inclined to institute a new genus for this while there is a probability it may be the *fry of some larger Trilobite*" (italics Salter's). From this it is evident that Salter used the name only as a makeshift until the true nature of the fossil was revealed, and I can see no reason, sentimental or otherwise, why Microdiscus should continue to be employed as a name for Cambrian trilobites.

As I have not found specimens which can be identified with this species, I can only point out the ways in which it appears to differ from *R. semicostatus* and *R. powelli*.

Emmons's brief description was as follows: "Minute, oval, middle lobe of the cephalic shield strongly developed; ribs of the body or abdomen, four; of the tail, four or five."

As there are only four thoracic segments, it is evident that this is an immature specimen, a supposition borne out by its small size, length only 4 mm. The possibility that the adult would show one less segment in the pygidium must therefore be allowed, thus reducing the number to three or four, instead of four or five. Even this is more than in *R. powelli*, and in that species the ribs turn backward instead of forward as indicated in Emmons's figure. From *R. semicostatus*, Emmons's species differs in having a much narrower glabella.

Ampyx americanus Safford and Vogdes.

Plate 2, fig. 3, 4.

Ampyx americanus Safford and Vogdes, Proc. Acad. nat. sc. Phila., 1889, p. 166, fig. Vogdes, Amer. geol., 1893, **11**, p. 106, fig. 4.

The original locality for this species is at Bullsgap, Tenn., and the writer was fortunate enough to find a nearly complete specimen at that place, in the well-known outcrop under the railroad bridge east of the station. Although this specimen has lost the anterior spine, the base of it is present and shows that it was circular in section. This, with the presence of six segments in the thorax, proves the species to be a true Ampyx. Besides the whole specimen, several cranidia and pygidia were collected in the vicinity of Bullsgap.

Entire body broadly oval, but little longer than broad, with elongate glabellar and genal spines.

Cephalon nearly semicircular in outline, the oval glabella raised high above the broad depressed cheeks. Free cheeks narrow, eyeless, extended at the angles into long genal spines each of which has on its upper surface a deep longitudinal depression. Glabella highly elevated, ovate in outline, enlarging toward the front. On the outer surface there are indications of two pairs of glabellar furrows, and the interior of the shell shows distinctly three pairs. From the front of the glabella projects a long, thin spine which is directed somewhat upward and is circular in section.

The thorax consists of six segments, the pleura of which are nearly flat and deeply grooved. The axial lobe is a little less than one third the total width and not greatly elevated.

The pygidium is nearly semicircular, with a sharply deflected border, flat, smooth pleural lobes, and a slightly elevated, sharply defined axial lobe with 12–15 transverse rings which are much less prominent when the shell is preserved than on exfoliated specimens. There is, of course, an anterior half rib on each of the pleural lobes, and two or three pairs of very faintly defined ribs can sometimes be seen.

This species is characterized by the large size of some specimens and by the pygidium with its ringed axial and smooth pleural lobes.

Measurements: — Length of a small but nearly entire specimen (M. C. Z. 1,677), lacking glabellar spine, 18 mm., width 17 mm.; length of cephalon 8 mm.; length of thorax 5 mm.; width at front 15 mm., at back 12.5 mm.; width axial lobe at front 3.75 mm.; width pygidium 12 mm., length 5 mm.; width axial lobe at front 4 mm. A

somewhat imperfect cranidium is 21 mm. wide, and 15 mm. long, including the glabellar spine, which is 6 mm. long. An isolated pygidium is 15 mm. wide, and 6.5 mm. long; the axial lobe 3.5 mm. wide at the front.

Horizon and Locality: — This species seems to be quite common in the Athens about Bullsgap, Tenn., occurring in the thinly bedded limestone at the base, and in similar limestone higher in the section. It is not rare in the railroad cutting near Otes, north of Bullsgap. In Virginia I have found it in the quarries east of Saltville, at Chatham Hill north of Marion, and a single specimen in the Catawba Valley, north of Salem.

Ampyx laeviusculus Billings.

Ampyx laeviusculus Billings, Pal. foss. Canada, 1865, **1**, p. 295, fig. 285.

The following description is based on specimens from zone N_3, Table Head, Nfld. Cephalon about one half as long as wide, trilobate, the glabella being as wide as either of the fixed cheeks. Glabella large, wide, elevated, widest in front of the middle, with a short small spine directed forward from a point high on the elevated front. Besides the neck-furrow, the glabella has two pairs of shallow glabellar furrows on its posterior upper surface. The dorsal furrows are rather wide. Fixed cheeks smoothly convex. Free cheeks not seen, but apparently very narrow and mostly ventral.

Two segments only of the thorax have been seen. They are very short, the axial lobe is narrow, crossed by a backward curving furrow which divides it into two ridges, and the pleural lobe is crossed by a broad furrow which is parallel to the margins, and occupies practically all of the surface.

The pygidium is about one half as long as wide, the axial lobe narrow, the pleural lobes slightly convex, with an abruptly deflected border about the whole. At the line of deflection there is a low hair-like ridge. At the anterior end of the axial lobe there is a narrow furrow outlining one ring, and on each pleural lobe there is a similar one. Otherwise the surface is smooth, though faint indications of more rings and ribs are seen on some specimens.

Measurements: — A cranidium is 4 mm. long, and 10 mm. wide; and the glabellar spine is 3 mm. long. The glabella is 3.5 mm. wide. Another cranidium is 5.25 mm. long, and 11 mm. wide. The first of two thoracic segments associated with this cranidium is .75 mm. long; and the axial lobe 2 mm. wide. A pygidium on the same slab with this

is 5.5 mm. long, and 11.5 mm. wide. The axial lobe is 2 mm. wide at the front. Billings's figured pygidium was 4.5 mm. long, 10.5 mm. wide; and the axial lobe was 3 mm. wide at the front.

This species has not, so far as I know, been reported outside Newfoundland, but it is evidently closely allied to the Ampyx next to be described, a species found in the Liberty Hall and the top of the Holston in Virginia. Both have smooth pygidia, but the Virginian species lacks the rim on the abruptly deflected posterior border. *Ampyx americanus* has a wider axial lobe in the thorax, and the axial lobe of the pygidium is ringed. Although the pygidium of this species is easily recognizable, I have not yet found characteristics by which the cranidium is readily separated from that of other species of Ampyx or even from that of *Raphiophorus semicostatus*.

Horizon and Locality: — Billings's original specimens of this species, described from pygidia only, were from division N at Table Head, Nfld. Professors Schuchert and Twenhofel collected both pygidia and cephala in their zone 13, N_3, at Table Head, where the species occurs in a fine-grained, almost black, shale. The cephalon shows plainly that this species is an Ampyx.

Ampyx camurus, sp. nov.

Plate 2, fig. 5–7.

This species so far as known is small, with very convex glabella.

Cranidium convex, roughly triangular, with large prominent glabella, from the anterior end of which projects a conical spine of medium length. The glabella rises high above the cheeks, the anterior end projects beyond them, and the greatest width is in front of the middle. The posterior part of the glabella is somewhat constricted by two pairs of pits which represent the glabellar furrows. The spine is curved gently upward in one specimen, but whether this is the general rule cannot be stated as it seems to be broken off from all others.

No part of the thorax has been seen.

Pygidium short and wide, with a prominent axial lobe. Both axial and pleural lobes are devoid of transverse furrows except for the anterior one. The posterior part is sharply deflected, but there is no carination at the angle.

Measurements: — A cranidium from Lexington, Va., is 7 mm. long (without the spine), and about 11 mm. wide. The glabella is 5 mm. wide. A pygidium from the same locality is 4 mm. long. A cranidium

from the Thomas farm, east of Blacksburg, is 5.5 mm. long, and about 13 mm. wide. A pygidium is 3 mm. long, and 7.5 mm. wide.

The species is more nearly allied to *Ampyx laeviusculus* than to any other American species, but can readily be recognized by the fact that the pygidium lacks the rim at the angle of the abruptly deflected border which is so well developed in that species. From *A. americanus* it differs in lacking the rings on the axial lobe.

Horizon and Locality: — This species is common in the lower beds of the Liberty Hall at Lexington, Va., and in the top of the Holston at the Thomas farm, three miles northeast of Blacksburg, Va. Cotypes (M. C. Z. 1,668, 1,669).

Lonchodomas normalis (Billings).

Ampyx normalis Billings, Pal. foss. Canada, 1865, **1**, p. 295, fig. 286.
Ampyx (*Lonchodomas*) *normalis* Grabau and Shimer, N. A. index fossils, 1910, **2**, p. 259.

There are no complete specimens in the collection, but two show a part of the thorax, so that a little can be added to Billings's description. If my identification of this species is correct, the glabella is normally a little wider than is indicated by Billings's figure. In the figure, the glabella is 3.5 mm. wide at the widest point, and the cephalon 14 mm. wide, the index being .25. A very well-preserved specimen from N_2, Table Head, Nfld., has the glabella 4.5 mm. wide and the cephalon only 16 mm. wide, the index being .28. Measurements show the difference to be less than inspection would suggest, the appearance of greater width being due to the fact that the sides of the glabella are not so nearly parallel as shown in the figure.

Cranidium roughly triangular, the glabella elevated high above the cheeks and extending a short distance beyond them. Cheeks depressed, convex, smooth. Free cheeks not seen, but evidently very narrow. Glabella narrow at the back, expanding gradually forward and widest near the anterior ends of the fixed cheeks. On exfoliated specimens three pairs of glabellar furrows are present in front of the neck-furrow, and more rarely one sees a pair of deep pits in the dorsal furrows opposite the widest part of the glabella. On specimens with the test, only the posterior two pairs of furrows are visible. The glabellar spine is about as long as the glabella, straight, slender, and prismatic in section.

Axial lobe of thorax narrow, a little less than one fourth the total width. Pleural lobes flat, with broad straight furrows.

Pygidium roughly triangular, with a narrow, highly inclined border. Axial lobe narrow, with eight or ten incomplete rings indicated by short transverse ridges on the top. Pleural lobes smooth, except for the anterior furrow.

The figure given by Billings is too long and does not show the highly inclined border.

Measurements: — A cranidium from zone N_2, Table Head, Nfld., is 9.5 mm. long, 16 mm. wide; glabella 4.5 mm. wide; glabellar spine 9 mm. long. A pygidium from the same locality is 6 mm. long, 14 mm. wide; axial lobe 4 mm. wide at the front.

The last four segments of the thorax of a specimen from zone N, at Table Head, are together 4 mm. long. The anterior of them (2d segment) is 14 mm. wide, and its axial lobe is 3.5 mm. wide.

Ulrich has identified *Lonchodomas normalis* in the lower Echinosphaerites zone of the Chambersburg in the Chambersburg quadrangle and "Ampyx n. sp. *cf. A. normalis* and *A. halli*" in the Nidulites zone. The writer has been able to find only one species of Lonchodomas in the Chambersburg, either in the Chambersburg quadrangle in Pennsylvania or at Strasburg, Va. This is the one described on a later page as *Lonchodomas sublaevis* and differs from *L. normalis* in the large broad, depressed, unfurrowed glabella. I have not yet found Lonchodomas in the Athens of Virginia, but in Tennessee one finds *Lonchodomas politus*, which is somewhat like *L. normalis*, but has shorter fixed cheeks and no glabellar furrows.

Lonchodomas halli (Billings) of the Chazy has very much shorter fixed cheeks than *L. normalis*, and the pleural lobes of the pygidium are also ribbed in that species.

Horizon and Locality: — Billings reported this species from division N, Table Head and Pistolet Bay, and division P, four miles N.E. from Portland Creek, Nfld. I find it in the Schuchert and Twenhofel collection from zone M_2, zone N_1, the Isolated limestone, and zone N_2, all at Table Head, Nfld, and of Normanskill age.

Lonchodomas politus, sp. nov.

Plate 2, fig. 8–10.

This species is known only from cranidia and pygidia. The glabella is narrow, carinate, does not expand greatly forward, and contracts abruptly into an unusually long, slender, prismatic spine. The fixed cheeks are short and depressed, the free cheeks probably wide. Gla-

bellar furrows represented by a pair of scars on the sides not far in front of the neck-furrow, and a pair of pits in the dorsal furrows opposite the widest part of the glabella. Some, but not all specimens, have along the axial line a narrow carina which is seen only when the shell is removed.

The facial sutures truncate the cranidium laterally, the course being sufficiently inward to produce a concave outline.

Associated with the cranidia in one locality are small pygidia which probably belong to this species. The outline is nearly triangular, the posterior margin very steep, and the axial lobe wide, without rings. The pleural lobes have one pair of distinct furrows, limiting the usual anterior half rib, and two pairs more of ribs are faintly outlined. The surface is punctate.

Measurements: — A cranidium from the Athens near Bullsgap is 9 mm. wide, and 15 mm. long, including the spine, which is 9 mm. in length.

A pygidium from the Athens near Athens is 2.75 mm. long, and 8 mm. wide; the axial lobe being 2 mm. wide at the front.

This species resembles *Lonchodomas halli* (Billings) of the Chazy, having short fixed cheeks and a carinate glabella. It differs in lacking the glabellar scars of that species, and in tapering much more rapidly from the glabella into the spine. The short cheeks and absence of glabellar furrows distinguish it from *L. normalis*, and the carinate glabella is quite different from the flat one of *L. sublaevis*.

Horizon and Locality: — This species was first found in the Ottosee east of the quarries at Saltville, Va., and the next year near the base of the Athens two miles south of Bullsgap, Tenn. It is very common in a limestone at about the middle of the Athens, two miles northeast of Athens, Tenn. Holotype (M. C. Z. 1,673); paratypes (M. C. Z. 1,671, 1,672).

Lonchodomas sublaevis, sp. nov.

Plate 2, fig. 11, 12.

This species is known only from cranidia, all of which are of large size for the genus.

Cranidium triangular, with broad, gently convex glabella. Fixed cheeks depressed, convex, triangular, extending nearly to the front of the glabella. Glabella only moderately convex, broadest at about the middle, and without glabellar furrows. In spite of the relative flatness of the top there is an obscure longitudinal carina.

Measurements: — One cranidium is about 13 mm. long, 14 mm. wide; and the glabella is 7 mm. wide. A smaller one is 8.5 mm. long, 13 mm. wide; and the glabella is 5 mm. wide.

The short cheeks and absence of glabellar furrows distinguish this species from *Lonchodomas normalis*. The cheeks are longer than in *L. halli* or *L. politus*, and it also has a more depressed glabella than either of those species.

Horizon and Locality: — This species has so far been found only in the Chambersburg formation. It is a rare species in the Lower Echinosphaerites and Nidulites zones in the section west of Marion, Pa., and in the Upper Echinosphaerites zone at Strasburg, Va. Cotypes (M. C. Z. 1,619, 1,620) from the former locality.

Endymioniidae Raymond.

Endymioniidae Raymond, Bull. M. C. Z., 1920, **64**, p. 277.

This family was erected for trilobites which resemble the Raphiophoridae in the possession of narrow free cheeks without eyes, and a short, Ampyx-like pygidium, but which lack a glabellar spine. The typical genus is Endymionia. The family may be briefly characterized as follows: —

Hyoparia with narrow dorsal free cheeks but no eyes, no glabellar spine, five to seven segments in the thorax, and a short ampycid pygidium.

Ordovician, Quebec, Newfoundland, Illinois, Scotland, Sweden.

Endymionia Billings. Cephalon evenly convex with large glabella divided into three parts by a pair of longitudinal furrows. Axial lobe of thorax about one third the total width. Type: — *Endymionia meeki* Billings. Lower and Lower Middle Ordovician, Quebec and Newfoundland.

Anisonotus Raymond. Cephalon irregularly convex, glabella small, with lateral furrows indicated by pits. Axial lobe of thorax narrow. Type: — *Shumardia glacialis* Billings. Lower and lower Middle Ordovician, Newfoundland, Scotland, Sweden. Other species which appear to belong to this genus are *Anisonotus horneri* (Nicholson and Etheridge) from the Balclatchie (Llandeilo) of Scotland, and *A. obtusus* (Moberg and Segerberg) from the Ceratopyge shales of Sweden.

Ampyxina Ulrich. Glabella hemispheric, reaching anterior margin of cephalon, one pair of glabellar furrows isolating basal lobes. Thorax with five segments. Type: — *Endymionia bellatula* Savage. Upper Ordovician, Illinois.

Endymionia Billings.

Endymion Billings, Pal. foss. Canada, 1862, **1**, p. 93.
Endymionia Billings, Ibid., 1865, **1**, p. 281.

This genus was described by Billings from a single nearly complete specimen found at Point Lévis. I have since found a couple of quite well-preserved cephala and a pygidium at the type-locality and shown (Amer. journ. sci., 1914, ser. 4, **38**, p. 530) that it comes from the thin-bedded limestone of the zone of *Diplograptus dentatus*, where it is associated with a considerable number of trilobites, brachiopods, and graptolites.

The conspicuous features of the typical species are: — Absence of eyes, oval glabella with elongate lateral lobes, six or seven segments in thorax, Ampyx-like pygidium. This from Billings's specimen. Specimens collected by myself show that very narrow lateral free cheeks must have been present.

Billings changed the name Endymion to Endymionia because he had learned that the former had been used for a genus of plants. This would not, of course, necessitate a change, but unfortunately Swainson used Endymion for a genus of Lepidoptera in 1832.

On the same page with the above change of name, Billings stated that *Endymionia meeki* occurred abundantly in divisions N and P in Newfoundland. Schuchert and Twenhofel were fortunate enough to collect some good material, including entire specimens, at one of the localities referred to by Billings, and although they prove to belong to a distinct species, they add somewhat to the generic diagnosis, as they show that the thorax possessed seven segments.

Endymionia meeki Billings.

Endymion meeki Billings, Pal. foss. Canada, 1862, **1**, p. 94, fig. 84.
Endymionia meeki Billings, Pal. foss. Canada, 1865, **1**, p. 281.

It is not necessary to redescribe this species, but it may be pointed out that since other species of the genus have proved to have seven thoracic segments, it is highly probable that seven rather than six was the correct number in Billings's imperfect specimen. Specimens collected by the writer show that narrow marginal free cheeks were doubtless present. A pygidium from Point Lévis is somewhat better preserved than that on the original specimen and has five rings on the broad slightly convex axial lobe and three pairs, besides the anterior

half rib, on the flat pleural lobes. There is a wide, flat, striated border sloping down all around at an angle of 45°, and at the junction with the flat upper surface is a narrow, raised, wire-like rim.

Measurements: — Billings gives the following measurements of the type: — Length of specimen 5 lines (10 mm.), width at posterior margin of head, about 4 lines (8 mm.); length of head $2\frac{1}{4}$ lines (4.5 mm.); length of thorax $1\frac{3}{4}$ lines (3.5 mm.); length of pygidium about 1 line (2 mm.). A cranidium from Point Lévis is 4.5 mm. long, and 9 mm. in width. The glabella is 3.75 mm. long, and 3 mm. wide. A pygidium is 2.5 mm. long, 6 mm. wide.

Horizon and Locality: — This species has been found only at Lévis, opposite Quebec, P.Q., where Billings reported it from the "upper part of limestone No. 2, Quebec Group," and where I found it, as a very rare fossil, in the thin-bedded limestone at the base of the zone with *Diplograptus dentatus*, in the Lévis formation, Beekmantown in age. The particular locality is in the crest of the bluff overlooking the road near the base of Begin Hill, about one half mile east of the station at Lévis.

Endymionia schucherti Raymond.

Plate **2**, fig. 13.

Endymionia schucherti Raymond, Bull. M. C. Z., 1920, **64**, p. 277.
Endymionia meeki Billings (*partim*), Pal. foss. Canada, 1865, **1**, p. 281.

Specimens of this species are larger than those of *E. meeki*, with smooth rather evenly convex cephalon, and flattened thorax and pygidium. Lengths of cephalon, thorax, and pygidium in the proportion 2 : 2 : 1.

Cranidium a little more than twice as wide as long, smooth, gently and evenly convex. Glabella very large, depressed convex, with large lateral lobes strongly suggestive of Amphilichas. The outline of the whole glabella is roughly circular, the width being a little greater than the length of the glabella and neck-ring. The confluent glabellar furrows follow exactly the same course as do those of an Amphilichas, separating large, oval, diagonally placed lateral lobes. The central lobe is narrowest a short distance in front of the neck-furrow, and widest at the front. In front of the glabella the cheek slopes down to a very narrow flattened or concave border which is absent from the sides, where narrow, free cheeks extending back to the genal angles and perhaps elongated into genal spines were probably present. No evidence of the presence of eyes remains, and it is probable that like

the Raphiophoridae these were blind trilobites with dorsal facial sutures. The neck-furrow is distinct all across the back of the cephalon, but narrow. The neck-segment is wider near the distal ends than near the axial lobe.

The thorax has seven narrow segments, the axial lobe being gently convex and the pleural lobes flat. The axial lobe is rather wide, nearly one third the total width, and tapers very little from front to back. On the pleural lobe each segment shows a rather wide, deep, central furrow.

The pygidium is short, Ampyx-like, with four rings on the wide axial lobe and three pairs of ribs on the pleural lobes, and is surrounded by a steeply sloping striated border.

Measurements:— Length of entire specimen: 10 mm.; width at genal angles 9 mm.; length cephalon 4 mm.; thorax 4 mm.; pygidium 2 mm.; width glabella 3.75 mm.; width axial lobe at front of thorax 2.5 mm., at front of pygidium 2 mm.; width pygidium at front 6.5 mm. Largest cranidium length 9 mm., width 15 mm.; width glabella 8 mm., length glabella 7.5 mm.

This species is similar to *E. meeki*, and I should not have been able to separate the two had not specimens of both been before me. In *E. schucherti* the glabella is more nearly circular in outline, broader, and flatter than in *E. meeki*, and the median tubercle is fainter and farther forward, so faint in fact as to be invisible on most specimens. In *E. meeki* there is a strongly striated, abruptly sloping, border in front of the glabella, while in *E. schucherti* the corresponding portion is a smooth "roll" sloping down to a narrow concave border.

Horizon and Locality:— Professors Schuchert and Twenhofel collected twelve specimens, three of them entire, from the limestones of division N (Normanskill) at Table Head, Nfld. Billings referred to this form as occurring abundantly in division N at Table Head and the west side of Pistolet Bay, also in division P, four miles northeast from Portland Creek, Nfld. The types are in the Yale University Museum. Named for Prof. Charles Schuchert.

Anisonotus glacialis (Billings).

Plate 2, fig. 17.

Anisonotus glacialis Raymond, Bull. M. C. Z., 1920, **64**, p. 279.
Shumardia glacialis Billings, Pal. foss. Canada, 1865, **1**, p. 238, fig. 270.

Entire trilobite oval in outline, nearly as wide as long, the greatest width being at the back of the cephalon. The cephalon is strongly

convex; the thorax and pygidium nearly flat except for the axial lobe, which is narrow and elevated.

The cephalon is trinuclear, the swollen glabella rising above the mound-like fixed cheeks. The glabella extends two thirds of the length of the cephalon (measured on the curvature) and shows at the sides four pairs of pits. The last pair represent the neck-furrow, and the others the fourth, third, and second pairs of glabellar furrows. The first and fourth pairs of pits are much less conspicuous than the others. The elevated glabella is bounded by a pair of narrow furrows which converge backward and outside these are two more which are parallel to the axis of the head. Between the parallel and the converging furrows are two slightly elevated triangular ridges, the apices pointed forward.

Outside the parallel furrows on the cephalon there are two evenly rounded mounds, limited on the inside and back by straight grooves intersecting at right angles and at the front by a curving depression which joins the dorsal furrows opposite the anterior glabellar furrows. In this depression there is on each side a narrow but distinct eye-line which curves backward around the mound and continues to the border of the cheek, meeting it at the horizon of the neck-furrow. In front of this depression and of the glabella there is a rather abrupt bulging slope to the margin, which appears to be somewhat thickened, but probably without rim or brim. The exfoliation of the type gives the appearance of a very narrow brim on the front.

At the genal angles the fixed cheeks are drawn back into short lapets which extend behind the neck-ring. These are semicircular in outline, and it is difficult to decide whether they are the actual genal angles, or whether they were enveloped by spines belonging to the free cheeks. In front of the angles there is a slight sinuosity in the side of the cheek, and along this part the border which is present on the front of the cephalon is absent. This seems to indicate that free cheeks should be present, but very narrow ones as in most species of Ampyx. These cheeks would probably have borne the genal spines.

The anterior portion of the cephalon is covered with very fine wavy lines, parallel to the anterior edge.

The thorax has seven segments, and does not taper from front to back. The axial lobe is narrow, one fifth of the total width, and strongly elevated. The pleural lobes are flat, each pleuron bearing a linear groove whose course is at right angles to the axis. The first two segments do not extend quite so far at the sides as those behind, a common condition in trilobites with genal spines.

The pygidium is nearly semicircular, but has the somewhat triangular appearance so often seen in pygidia of ampycids or trinucleids. The axial lobe is narrow, elevated, and extends almost to the posterior border. The pleural lobes are flat, and turn down but little to the very narrow thickened margin. Singularly enough, there is a ring on the axial lobe for each pair of ribs on the pleural lobes, so that rings and ribs are continuous. Nine distinct rings are present. The ribs are narrow and flat, with just a suggestion of an impressed line along the top.

Measurements: — Length 14.5 mm., greatest width 13 mm., width at middle of thorax 10.5 mm.; length of cephalon 6.5 mm., width 13 mm.; length glabella 4.5 mm., width of glabella at front 3.25 mm.; length of thorax 4 mm., width 10.5 mm.; width of axial lobe 2 mm.; length of pygidium 3.25 mm., width at front 9 mm.; width of axial lobe at front 1.5 mm. A flattened cephalon is 6 mm. long, 15 mm. wide; and the glabella is 4.5 mm. long.

This species differs in many respects from *Endymionia meeki*. The glabella is shorter and considerably narrower, has four instead of two pairs of pits at the sides, and has much less prominent lobes beside it. *E. meeki* does not seem to have the mound-like cheeks, and eye-lines are absent. The axial lobe of the thorax is much narrower in *A. glacialis* than in *E. meeki*, and the furrows on the pleura are straight instead of sinuous. The pygidium of the present species has a narrower axial lobe and more rings and ribs than in the Beekmantown form.

With the knowledge of this specimen it is possible to get a better idea of the characteristics of the Endymionidae. The form of the thorax and pygidium and the presence of narrow free cheeks approach very closely to the Raphiophoridae, being excluded from that family as now defined only by the shortness of the glabella and the absence of a long spine therefrom.

Horizon and Locality: — Billings's specimens came from the conglomerates of Portland Creek and Pistolet Bay, Nfld. Hyatt found it on the east side at Port au Port, and Schuchert and Twenhofel obtained three fragments from the same locality. The horizon is their zone 6, Normanskill. Genoholotype (M. C. Z. 1,594).

Anisonotus hornei (Nicholson and Etheridge).

Ampyx mammillatus Armstrong and Young, Cat. est. Scot. foss., 1876, p. 15.
Ampyx hornei Nicholson and Etheridge, Mon. Silur. foss. Girvan, 1879, p. 184, pl. 13, fig. 4, 8. Mem. Geol. surv. Silur. rocks Britain, 1899, 1, Scotland, p. 509, 672, 688. Reed, Palaeontogr. soc., 1903, p. 19, pl. 3, fig. 8–10.

?Asaphus sp. Nicholson and Etheridge, Mon. Silur. foss. Girvan, 1879, p. 154, pl. 10, fig. 20.

This species, of which the cranidium, part of thorax, and the pygidium have been well described and figured by Reed, is evidently an Anisonotus. The cranidium shows the long eye-lines and the glabella does not reach the front. The thorax is said by Reed to have six segments, and the pygidium agrees well with that of *Anisonotus glacialis*. *A. hornei* is from the Balclatchie Group (Llandeilo) of Scotland, and thus occurs at about the same horizon as *A. glacialis*.

Anisonotus obtusus (Moberg and Segerberg).

Ampyx obtusus Moberg and Segerberg, Lunds univ. ärsskr., 1906, n. f., **2**, p. 100, pl. 7, fig. 8–10.

This species agrees with Anisonotus rather than Ampyx in lacking a glabellar spine, and in the presence of a median pustule on the glabella. The glabellar furrows are merely faint pits, the eye-lines are very far forward, and the pygidium is nearly smooth, only faint traces of rings and ribs being visible.

Horizon and Locality: — The specimens were derived from the Ceratopyge shales (basal Ordovician), at Berg in Oestergotland.

Ampyxina Ulrich.

Ampyxina Ulrich, Bull. Geol. soc. Amer., 1922, **33**, p. 206.

This generic name was proposed by Ulrich in the published abstract of a paper read before the Palaeontological Society in December, 1921. His description is as follows: —"A new genus, *Ampyxina*, is proposed for small Ampyxidae with small and very short rostral spine, obovate glabella, a small pair of isolated posterior lateral glabellar lobes, and four or five thoracic segments. The pygidium also differs from that of *Ampyx* and *Lonchodomas* in wanting the thick, beveled and striated posterior edge. In *Ampyx* the second and third pairs of lateral glabellar lobes often are rather well developed and partly separated from the middle lobe, but the posterior pair is seldom well defined and never isolated."

As the genotype he designates, "provisionally," an unnamed trilobite described and figured by R. R. Rowley from the Maquoketa (Buffalo) shale west of Louisiana, Mo. For this he suggests the new name *Ampyxina bassleri*. Unfortunately this appears to be the species

described by Savage as *Endymionia bellatula*, and fails in some respects to fit the generic description, as it lacks a glabellar spine, has five segments in the thorax, and a rather sharply deflected, rim-like border on the pygidium.

At the time Dr. Ulrich's article appeared, I had in manuscript a new generic name for trilobites with the structure of *Endymionia bellatula*, but am now obliged to substitute the one he has proposed.

Ampyxina bellatula (Savage).

Gen.? sp.? Rowley, Missouri bur. geol. and mines, 1909, ser. 2, **8**, p. 60, pl. 15, fig. 12–14.

Endymionia bellatula Savage, Trans. Ill. acad. sci., 1917, **10**, p. 273, pl. 1, fig. 3. Foerste, Bull. Denison univ., 1920, **19**, p. 218.

Ampyxina bassleri Ulrich, Bull. Geol. soc. Amer., 1922, **33**, p. 206.

This species was first noticed by Mr. R. R. Rowley, who gave three figures of specimens without assigning any name to them. He stated that it was not rare in the lower beds of the "Hudson River," four or five feet above the top of the Trenton. Savage, in his description, does not refer to Rowley's description or figures, but notes its occurrence near Dover Church, Pike Co., Mo. Foerste says "Prof. R. R. Rowley discovered long ago a locality on the Goodman place, $\frac{1}{2}$ mile west of Calumet post-office, where this little trilobite [*Endymionia bellatula* Savage] occurs in great abundance about 3 or 4 feet above the base of the Buffalo shales." Ulrich does not give any description, but applies the name *Ampyxina bassleri* to the specimens figured by Rowley. The latter, judging from the figures and descriptions, belong to Savage's species, so his specific name has priority.

Endymionia bellatula is a small trilobite which combines some of the characteristics of Endymionia, Dionide, and Raphiophorus. The general aspect is that of Endymionia, from which it differs chiefly in having a longer glabella, which reaches the anterior margin, and only five instead of seven segments in the thorax. It is somewhat more like Raphiophorus with which it agrees in having five segments in the thorax and a bulbous glabella. As in that genus, the first thoracic segment is broader than the others, and has more curved furrows on the pleura.

The glabella has a pair of diagonal furrows which isolate small basal lobes, and the cheeks do not appear to have either genal caeca or the characteristic ornamentation of Dionide.

This condition is similar to that in Endymionia, except that the

lobes are very much smaller, and since the dorsal furrows are straight and parallel in the posterior parts of their courses, the resultant appearance is more nearly like that of Tretaspis than Endymionia.

The appearance of crushed specimens is so much like that of flattened specimens of Raphiophorus that they would naturally be referred to that genus were it not for the absence of a glabellar spine.

Ampyxina and Dionide are alike in having a bulbous glabella and in the differentiation of the first of the thoracic segments from the others. The glabellar furrows are, however, differently placed, there are five instead of six thoracic segments.

Professor Savage was good enough to send me a number of specimens of this species, and I am able to modify his excellent description only in regard to the glabellar furrows and the first segment of the thorax. Nearly all the cranidia are so flattened that the glabellar structure is obscure, but a few, particularly one preserving the test and exposed from the lower side, show that the dorsal furrows are straight and parallel nearly to the front of the cranidium. On either side of the glabella is a groove which originates in the dorsal furrow and runs back into the neck-furrow, thus isolating a pair of long, narrow basal lobes, and producing a nearly circular outline for the central part of the glabella. One uncrushed cranidium shows that the glabella is elevated high above the fixed cheeks and reaches to the anterior margin. If free cheeks were present on the dorsal surface, they must have been very narrow.

The furrows on the last four segments of the thorax are nearly straight, but each crosses its pleuron diagonally, being near the anterior edge mesally and the posterior one at the outer end. The first segment is wider than the others, and the groove, originating at the posterior inner angle, describes a graceful curve forward, nearly reaching the anterior margin at the middle, and the posterior angle at the outer end of the pleuron. Similarly marked first segments are present on some species of Dionide and Raphiophorus.

Horizon and Locality:— Savage reports the species from the Thebes sandstone (Richmond) near Thebes, Ill., also along Madison Creek, Calhoun Co., Ill., and near Dover Church, Pike Co., Mo. Foerste records its discovery by Rowley near Calumet post office, Mo., in the Buffalo shales (Maquoketa). Rowley gave no locality.

OPISTHOPARIA Beecher.

Olenidae Burmeister.

Triarthrus Green.

Triarthrus seems to be very largely a North American genus, and reaches its greatest development in our Middle Ordovician. It is, however, an olenoid trilobite, and is to be looked upon as a survivor of the Upper Cambrian fauna. Such being the case, it is rather surprising that members of the genus are relatively rare in early Ordovician faunas in America. In northern Europe, however, the majority of the species occur low in the Ordovician, but do not seem to be common.

List of the Species with References and Horizons.

American species.

Beekmantown.

Triarthrus belli Matthew, Bull. Nat. hist. soc. New Brunswick, 1902, no. 20, p. 412, pl. 18, fig. 8.

Normanskill.

Triarthrus fischeri Billings, Pal. foss. Canada, 1865, **1**, p. 291, fig. 280.

Upper Middle Ordovician.

Triarthrus becki Green, Mon. tril. N. Amer., 1832, p. 87, pl. 1, fig. 6. Trenton and "Utica" shales.

Triarthrus becki macasteycnsis Twenhofel, Bull. Victoria mem. mus., 1914, **3**, p. 35. Macastey shale ("Utica").

Triarthrus billingsi Barrande, Syst. Silur. Bohême. Suppl., 1872, p. 427, pl. 32, fig. 4, 5. Utica.

Triarthrus canadensis Smith, Canad. journ., 1861, new ser., **6**., p. 275, fig. Gloucester ("Utica").

Triarthrus glaber Billings, Canad. nat. geol., 1859, **4**, p. 382. "Utica."

Triarthrus spinosus Billings, Geol. surv. Canada. Rept. progr., 1853–1856, 1857, p. 340. Gloucester ("Utica").

European species.

Ceratopyge zone (Basal Beekmantown).

Triarthrus angelini Linnarsson, Kongl. svenska vet.-akad. Handl., 1869, **8**, p. 70, pl. 2, fig. 28. Sweden and Norway.

Lower Dicellograptus zone (Normanskill).

Triarthrus becki humilis Hadding, Lunds univ. ärsskr., 1913, n.f., **9**, p. 69, pl. 6, fig. 18, 19. Sweden.

Triarthrus jemtlandicus Linnarsson, Geol. fören. Förhandl., 1875, **2**, p. 493, pl. 22, fig. 2, 2a. Sweden.

Triarthrus becki Green (var.) Reed, Palaeontogr. soc., 1903, **57**, p. 28, pl. 4, fig. 10. Balclatchie group (Llandeilo), Scotland.

Upper Middle Ordovician.

Triarthrus becki Green. Linnarsson, Kongl. Svenska vet.-akad. Handl., 1869, **8**, p. 70, pl. 1, fig. 27. Chasmops limestone (Trenton). Sweden.

Upper Ordovician.

Triarthrus pygmaeus Törnquist, Sveriges geol. undersokning, 1884, ser. C, no. 66, p. 38, pl. 1, fig. 40. Trinucleus shales (Richmond), Sweden.

In the above list of the eight American species and varieties, six are Upper Middle Ordovician (Trenton and Utica), whereas in Europe three of the six species are Lower Middle Ordovician, one Lower Ordovician, one Upper Middle, and one Upper Ordovician.

Several of the species are imperfectly known and seem to lack striking distinguishing characteristics. *Triarthrus canadensis* and *T. spinosus* are of course somewhat sharply separated from the other species by their spines.

Triarthrus fischeri Billings.

Triarthrus fischeri Billings, Pal. foss. Canada, 1865, **1**, p. 291, fig. 280.

Triarthrus fischeri was poorly described and figured by Billings, and has not been redescribed. Of the species from the Utica, *T. glaber* is most like *T. fischeri*, the two agreeing in lacking spines and in having no tubercles along the axial lobe. Although not shown in Billings's figure, *T. fischeri* has a narrow, upturned rim in front of the glabella. This rim is separated from the glabella by a narrow furrow, which, in this species extends around the front of the cranidium, whereas in *T. glaber* and *T. becki* the circumglabellar furrow is not confluent with the furrow inside the rim on the cheeks. The glabella of *T. fischeri* contracts slightly toward the front; in *T. becki* it expands. As Billings has remarked, the specimens from the Trenton and Utica are much larger than those from the Normanskill. Comparison should rather be made with the species found at the same horizon in Europe.

Of the latter, *T. becki humilis* Hadding differs in having the eyes farther forward, the glabellar furrows more arcuate, and in lacking the anterior pair of furrows. The species described by Reed from the Girvan district of Scotland as *Triarthrus becki* is entirely unlike both

T. fischeri and *T. becki* in having almost straight glabellar furrows, and with the neck-furrow of the glabella confluent with that of the cheeks. As the Scottish species is certainly not identical with *Triarthrus becki* I propose that it shall be known as *Triarthrus reedi*.

Triarthrus jemtlandicus has been best described and figured by Wiman (Bull. Geol. inst. Upsala, 1902, **6**, p. 79, pl. 5, fig. 5–8), who rightly objected to Holm's uniting it with *T. becki*. Specimens from the type-locality, figured by Wiman, are distinctly pointed in front, have very narrow glabellar furrows, faint dorsal furrows, and are in general quite different from all other species of the genus.

Triarthrus fischeri is therefore quite distinct from other species found at the same horizon, but quite like the later *Triarthrus glaber*.

Horizon and Locality: — Billings's specimens of this species were found in division N at Table Head and Pistolet Bay, and in division P at Portland Creek, Nfld. The specimens in the M. C. Z. were obtained by Professor Hyatt on the eastern shore of the Bay at Port au Port, Nfld.

Professors Schuchert and Twenhofel collected cranidia from zone N_2 and the Isolated limestone at Table Head, and cranidia and fragments of the thorax from Port au Port.

Triarthrus reedi, sp. nov.

Triarthrus becki var. Reed, Palaeontogr. soc., 1903, **57**, p. 28, pl. 4, fig. 10.

As mentioned (page 51) the Scottish form which has been identified as *Triarthrus becki* differs from that species in having almost straight glabellar furrows, and in having the neck-furrow continuous across the cheeks and posterior end of glabella. It appears to occur at a lower horizon (Llandeilo) than does the true *T. becki*.

Triarthrus caecigenus Raymond.

Plate **2**, fig. 16.

Triarthrus caecigenus Raymond, Bull. M. C. Z., 1920, **64**, p. 280.

Entire test oval, of the usual shape in this genus, without spines or pustules except for a small one on the neck-ring.

Cephalon somewhat irregular in outline, the glabella projecting in front of the cheeks. Glabella long and wide, with a very narrow circumglabellar furrow and upturned border. There are two pairs of glabellar furrows which run inward and somewhat backward and are

deeply impressed, particularly at their inner ends. Fixed cheeks narrow, with a somewhat wide convex marginal border which extends around the sides and connects with the neck-ring. A truncation of this border at the sides suggests the possible former presence of very narrow free cheeks, but there are no traces of palpebral lobes.

Thorax with (apparently) eleven segments. Axial lobe wide and the rings smooth.

Pygidium strongly segmented, with about six pairs of ribs on the pleural lobes and seven rings on the axial lobe.

Measurements: — Length 11.5 mm. Length cephalon 3.5 mm.; thorax 5.5 mm.; pygidium 3 mm. Width at genal angles 6 mm.; width glabella 3 mm.; width axial lobe at front 2.75 mm.; width pygidium 4 mm.

This species can be distinguished from all others by the absence of eyes. The most closely allied species is *Triarthrus humilis* Hadding which has the eyes far forward and the free cheeks very narrow.

Horizon and Locality: — A rather common species in the Athens shale in the Catawba Valley, north of Salem, Va., where the type was collected by Prof. S. L. Powell, and also at Lasker's Gate, three miles northeast of Blacksburg, Va., where it was collected by Dr. R. M. Field and the writer. A few specimens were also found at Saltville, Va., near the base of the Athens. Holotype (M. C. Z. 1,593).

Ceratopygidae Raymond.

Crepicephalus ceratopygoides, sp. nov.

Plate 2, fig. 15.

Among the fossils collected by Mr. Shepard in British Columbia is a rather poorly preserved pygidium which closely simulates that of Ceratopyge, but is more probably referable to Crepicephalus, a genus hitherto supposed to be confined to the Cambrian.

Cephalon and thorax unknown.

Pygidium approximately semicircular, with a pair of lateral spines projecting from the pleural lobes just back of the middle. Axial lobe narrow, with five conspicuous and two faint rings. Pleural lobes poorly preserved, but apparently smooth except for a pair of furrows just behind the anterior margin. The lateral spines are not mere extensions of the margin, but are prolongations of the convex portion of each pleural lobe.

This species belongs to the *Crepicephalus texanus* group, but is not

very closely allied to any known species. It has a wider pygidium, the axial lobe is narrower, and has more rings, than any species previously described. In the features just enumerated it is much more like *Ceratopyge forficula* Sars than like any Crepicephalus. It would be referred to Ceratopyge were it not for the fact that in that genus the spines are outlined as a distinct segment all across the pleural lobes.

One reason for the reference of this pygidium to Crepicephalus is the presence in the collection from the same locality of a small cranidium (Plate 2, fig. 14) which appears to belong to that genus, although whether it represents the same species as the pygidium is problematical.

The specimen (M. C. Z. 1,675) is very small (4 mm. long) and doubtless represents an immature specimen. The glabella is highly convex, unfurrowed, and its really semielliptical shape is obscured by a pair of pits in the circumglabellar furrow near its anterior end. At the anterior margin of the cephalon there is a raised border, and in the furrow behind it, obscure traces of three pits, suggesting those of some species of Crepicephalus. These pits are so faint that it was thought best not to attempt their illustration.

Measurements:— The pygidium, which is the holotype (M. C. Z. 1,674), is 14 mm. long, and 27 mm. wide. The axial lobe is 6 mm. wide at the anterior end, and 12 mm. long. A pygidium of *C. texanus* figured by Walcott is 15 mm. long, 25 mm. broad; and the axial lobe is 10 mm. wide.

Horizon and Locality:— The holotype was collected by Dr. Francis P. Shepard from the Lower Ordovician east of Harrogate, B. C., associated with a fauna characteristic of the Pogonip formation.

Solenopleuridae Angelin.

Ischyrotoma, gen. nov.

This generic name is suggested for small Opisthoparia with short highly convex cephalon, small eyes near the glabella, long, convex, oval glabella with no or inconspicuous lateral furrows, and steeply sloping cheeks which produce a strongly notched appearance at the front of the head. Type: — *Ischyrotoma twenhofeli*, sp. nov.

Ischyrotoma twenhofeli, sp. nov.

Plate 3, fig. 1, 2.

Cephalon narrow, trilobed, highly convex. Glabella long, semicylindrical, the anterior end rounded and overhanging the frontal

border. Very faint traces of two pairs of glabellar furrows are shown by slight indentations in the sides back of the eyes. The dorsal furrows are deep and narrow, the neck-furrow deep and wide, so that the glabella is completely isolated.

The fixed cheeks are narrow, the free cheeks convex, turned downward at the sides. Both eyes are broken off, but the position of one is shown opposite the middle of the glabella and close to the dorsal furrow. The genal angles appear to have been rounded, and the cheeks have a narrow convex outer border separated from the general surface by a narrow furrow. In front of the eye the facial suture runs nearly parallel to the dorsal furrow and close to it, turning inward to cut the margin near the middle of the front. Due to the broken surface the greater part of the course back of the eye cannot be seen, but it cuts the border at the genal angle.

The surface of the glabella bears numerous small pustules, and similar ones are scattered more sparsely over the cheeks.

Isolated glabellae might well be confused with those of Petigurus, Goniurus, and other trilobites, so that positive identifications cannot be made without fairly good material.

Measurements:— Length of cephalon 6 mm., width about 10 mm.

Horizon and Locality:— The holotype was obtained from a pebble in the Cow Head conglomerate at Lower Head, Nfld., and is in the Yale University Museum. A second specimen was collected by the writer from a boulder in the conglomerate on lot 22, Concession VI, two miles north of Mystic, Quebec.

Remopleuridae Corda.

This is a small family of relatively rare and specialized trilobites, characterized especially by the long eyes and flat glabella. It has been frequently stated that Remopleurides was a direct descendant of Paradoxides, and the genus placed in the same family with that form. A study of the older Ordovician species has suggested that it is more probable that the proximate ancestor is to be found in the Dikolocephalidae. These families approach each other most closely in Apatokephalus on the one hand and *Robergia micropthalma* on the other, and the tendency within the Remopleuridae seems to be toward a reduction in the size of the pygidium, suggesting that they had their origin in an isopygous group.

The following are the recognizable genera of this family:—

Remopleurides Portlock. Glabellar furrows faint or absent. Ante-

rior tongue of glabella usually short, without marginal border. Axial lobe of thorax wide, fulcral nodes strongly developed. Pygidium very short and broad with two pairs of short spines. Hypostoma bifurcated, with very long forks. Type: — *Remopleurides colbii* Portlock. Middle Ordovician, northern Europe and America.

Robergia Wiman. Glabellar furrows narrow but deeply impressed. Anterior tongue of glabella elongate and with a marginal border. Thorax narrow, axial lobe wide, pleural lobes very narrow and flat, without fulcral prominences. Pygidium flattened, with medium to long axial lobe, and three or two pairs of flat spines on the posterior margin. Hypostoma as in Remopleurides. Type:— *R. micropthalma* Linnarsson. Lower Middle Ordovician, northern Europe and North America.

Caphyra Barrande. Glabellar furrows distinct, anterior tongue of glabella short, a border present. Axial lobe of thorax wide, pleural lobes wider than in Robergia, fulcral nodes present, but not prominent. Pygidium long, narrow, and flat. Axial lobe short. Posterior margin with two pairs of spines. Hypostoma large, nearly square, not bifurcated. Type:— *Caphyra radians* Barrande. Upper Ordovician, Bohemia and Scotland.

Teratorhynchus Reed. Glabella with two pairs of furrows. Anterior tongue very long, with spines at the front. Thorax with wide axial lobe, narrow pleural lobes with weak development of fulcra. Pygidium short with two pairs of spines. Type:— *Teratorhynchus bicornis* Reed. Balclatchie Group, Llandeilo, Girvan district, Scotland.

Remopleurides panderi Billings.

Remopleurides panderi Billings, Pal. foss. Canada, 1865, **1**, p. 293, fig. 283.

This species appears to be rare, and is easily recognized by its small size and the deep pits which represent the posterior pair of glabellar furrows. These are situated far back on the glabella, and join the neck-furrow. Faint traces of another pair can be seen on some specimens.

Measurements: — Length of cranidium 1.5 mm.; width at palpebral lobes 1.75 mm.

Horizon and Locality: — Billings described this species from division N, Table Head, Nfld. Professors Schuchert and Twenhofel collected a few specimens from zone M_2 and from the Isolated limestone at Table Head, both of Normanskill age.

Remopleurides canadensis Billings.

Remopleurides canadensis Billings, Pal. foss. Canada, 1865, **1**, p. 182, fig. 164. Raymond, Ann. Carnegie mus., 1905, **3**, p. 334, 366, fig. 9, pl. 10, fig. 8–10. Bassler, Bull. 2a, Geol. surv. Virginia, 1909, p. 111, fig. 10. Raymond, Ann. Carnegie mus., 1910, **7**, p. 60. 7th rept. Vermont state geol., 1910, p. 217, pl. 32, fig. 8–10. Grabau and Shimer, N. A. index fossils, 1910, **2**, p. 270, fig. 1564.

Two glabellae of this species, each about 5 mm. long, were collected from the Holston in the Catawba Valley, north of Salem, Va. The surface is gently convex, faintly granulose, and with very slight traces of glabellar furrows.

Horizon and Locality: — The original locality of this species was in the Upper Chazy (Aylmer) in the front concession of the township of Clarence, Ontario, Canada. It is fairly common in the Middle Chazy at Valcour Island, and Chazy, N.Y., and rare in the Holston of the Catawba Valley, Va. Dr. Bassler has reported it from the Liberty Hall at Lexington, Va.

Remopleurides rugicostatus, sp. nov.

Plate **3**, fig. 3.

A single incomplete enrolled specimen appears to represent a species closely allied to *R. canadensis*.

The glabella is very smooth, without granulations, and the furrows are just barely perceptible. Neck-furrow and neck-ring narrow.

The thorax, which appears to be complete, has eight segments of the same kind as those of *R. canadensis*, but the most obvious difference between the two species is that in the form now described, the anterior part of each pleuron is longitudinally grooved.

The pygidium is too poorly preserved to be described in detail, but is apparently like that of *R. canadensis*.

Horizon and Locality: — The holotype (M. C. Z. 1,611) was collected by the writer from the Ridley limestone near Stone River, two miles northwest of Murfreesboro, Tenn.

Remopleurides striatulus Walcott.

Plate **3**, fig. 4, 5.

Remopleurides striatulus Walcott, Cinc. quart. journ. sci., 1875, **2**, p. 345, fig. 27A, a, b. Miller, N. Amer. geol. and pal., 1889, p. 566, fig. 1054, Foerste, Bull. Denison univ., 1920, **19**, p. 222, pl. 22, fig. 18A, B, C.

Walcott's original description of this species is accompanied by a rather sketchy figure of an entire specimen. I am therefore publishing a new figure, drawn from the type. Dr. Walcott obtained a number of cranidia and hypostomata from the original locality, but only two specimens which show anything of the pygidium, and both of these are somewhat damaged. The pygidium of the type is less well preserved than that of the other specimen. The latter shows that this shield is small, roughly rectangular in outline, longer than wide. The surface is evenly convex, sloping to the sides and posterior margin and is marked by neither axial lobe nor pleural ribs. The surface is crossed by cracks which at the anterior end are convex backward while on the posterior three fourths, they are concave backward. The posterior margin is not preserved, but appears to have had one or two pairs of blunt flat spines. This type of pygidium is very unlike that of *Remopleurides canadensis*, which is shorter than wide, and ends in distinct spines.

The glabella is moderately convex and its furrows are so obscure that they can only be made out by careful study, and on many specimens cannot be seen at all. The surface of the glabella is in some specimens granulated all over but in others it is very nearly smooth along the middle, and covered with sharp granules in the areas encircled by the eyes. These details are of course very difficult to show in illustration and in figures it is necessary either to leave off the glabellar furrows and ornamentation entirely, or exaggerate them.

Horizon and Locality: — The original examples collected by Dr. Walcott were from the upper third of the Trenton at Trenton Falls, N. Y. It has since been collected in the middle and upper Trenton at various places in Ontario. The cotypes are M. C. Z. 1,616–1,618.

Robergia schlotheimi (Billings).

Remopleurides ? schlotheimi Billings, Pal. foss. Canada, 1865, **1**, p. 294, fig. 284, a, b.

Apatokephalus schlotheimi Brögger, Nyt. mag. natur., 1897, **36**, p. 175, fig. 8a, b, p. 184.

Wiman proposed Robergia (Geol. fören. Förhandl., 1875, **2**, p. 494, pl. 22, fig. 3) for trilobites of the type of *Remopleurides microphthalmus* Linnarsson, which have the general aspect of a Remopleurides or Caphyra, but have a larger, broader pygidium, the glabella prolonged some distance in front of the eyes, and encircled by a narrow flat

border. Apatokephalus Brögger has a very similar head and pygidium, but the facial sutures turn abruptly outward in front of the eyes.

This species seems to be rather rare in Newfoundland, and I have seen specimens from only two localities, Port au Port, and St. John Island. Only cranidia and pygidia have been found, and these are all poorly preserved. The best specimens show that the glabella expands slightly in front of the eyes, and that there is a narrow flattened border around its front. The anterior glabellar furrows are very short, reduced to mere pits in some specimens; the median ones are long.

The pygidium, of which I have seen only a single example, is nearly rectangular, longer than wide, with the outer points reaching farther back than the inner ones, thus forming a reëntrant angle in the posterior outline. The axial lobe is elevated, narrow, tapering to an acute point a little back of the middle. It appears to have only two cross-furrows on it, these near the anterior end. The pleural lobes are practically flat, and at the posterior margin there are four blunt flat points or spines, the outer pair extending farther back and being broader than the others.

The cranidium of this species is exceedingly like that of *R. micropthalma* (*cf.* especially Hadding, Lunds univ. ärssk., 1913, n. f., **9**, p. 78, pl. 8, fig. 15–18), indeed, I see no important differences, but both species are, of course, imperfectly known. Billings thus describes the pygidia: —"The pygidium found in association with the glabella somewhat resembles that of *Dikelocephalus* [*Hungaia*] *magnificus*. It is ovate with an acutely conical axis, the side lobes with five or six well-defined ribs each. The axis is about half the whole length, and the ribs of the side lobes incline backward like those of a Remopleurides. The specimens are too obscurely preserved to be figured." From this it seems that the ribs on the pygidium were much more prominent than in the one I have before me, and unless a divided rib was counted by Billings as a pair, there were twice as many ribs as on the pygidium in the M. C. Z. specimen.

In any case, the outline of the posterior end of the pygidium is very different in the American and Swedish species. In *R. micropthalma* it is convex, and there are three pairs of spines, the outer ones being shortest, whereas in *R. schlotheimi* the outline is concave and the outer spines are longest.

Measurements: — A cranidium from Newfoundland is 7 mm. long, and 7 mm. wide at the palpebral lobes. The glabella extends 2.5 mm. in front of the palpebral lobes. A cranidium from the Catawba Valley, Va., is 2.5 mm. long, 2.25 mm. wide; and the glabella projects

.75 mm. ahead of the palpebral lobes. A pygidium from Newfoundland is 7 mm. long, and 5 mm. wide.

The specimen from Newfoundland differs from the next to be described in having the pygidium of different outline and with shorter and narrower axial lobe.

Horizon and Locality: — This species has so far been found only in division N at Port au Port and on the southern side of St. John Island, Nfld., and in the Athens in the Catawba Valley, thirteen miles north of Salem, Va.

Robergia major Raymond.

Plate **3**, fig. 6–10.

Robergia major Raymond, Bull. M. C. Z., 1920, **64**, p. 281.
Robergia sp. Raymond, Mem. Conn. acad. sci., 1920, **7**, p. 145, fig. 40.

Cephalon large, rounded in front, wider than long, with long narrow spines at the genal angles.

Glabella elongate, a little expanded in front of the long eyes, with three pairs of furrows on the wide portion between the eyes. In front of the glabella there is an extremely narrow flattened border. Free cheek narrow, extended backward into a narrow spine of about its own length.

Hypostoma bifurcated, with two very long prongs, as in Remopleurides.

Thorax known from two incomplete specimens, the larger with nine segments. Judging from these specimens the thorax is long, narrow, slightly tapering. The axial lobe is wide, convex; the side lobes flat and narrow, the individual segments ending in short spines.

Pygidium nearly square, as long as wide, sides straight and slightly convergent. Axial lobe elevated, extending three fourths of the length, wide at the front, tapering regularly backward. There are six well-marked rings. Pleural lobes practically flat, apparently crossed by obscure ribs, but all specimens are exfoliated, showing a wide striated doublure. The posterior margin shows two pairs of short flat spines, the inner ones being wider than the outer, and extending practically as far back.

Measurements: — A large cranidium is 15.5 mm. long, and 15 mm. wide at the palpebral lobes. Nine segments of a thorax are 7.5 mm. long, 4 mm. wide at the anterior end, and 3.5 mm. wide at the posterior. The axial lobe is 2.5 mm. wide at the front. A pygidium is 10 mm. long, 10 mm. wide at the anterior end, and 9 mm. wide at the posterior

end. The axial lobe is 5 mm. wide at the anterior end, and 7.5 mm. long.

This species is exceedingly abundant in the Athens at Saltville, Va., and though no complete specimens have so far been found, it is known from all the parts, including the hypostoma, which cannot be said of any other species of the genus. It differs but little from *Robergia schlotheimi*, such differences as there are being in the pygidium, which has a longer and wider axial lobe, is more nearly square, and has a straighter posterior margin. It differs from the Swedish *R. micropthalma* chiefly in the pygidium which is much more nearly square and has two instead of three pairs of spines.

Horizon and Locality: — A very abundant species in the lower part of the Athens at Saltville, Va., but not yet found elsewhere. Cotypes (M. C. Z. 1,601–1,606).

Robergia marginalis, sp. nov.

Plate 3, fig. 11.

A small trilobite, known from cranidia and pygidia only.

Cranidium similar to that of the type of the genus, but with a relatively wide brim in front of the glabella; this brim is depressed convex, without raised border, concentrically striated, and has a row of small circular pits in the depression adjacent to the glabella. Glabella moderately convex, narrow, granulose. The glabellar furrows are unusually lightly impressed for a Robergia. The posterior ones are short and rather deep, directed obliquely outward. The other two pairs are only lightly impressed, and are parallel to and of the same length as the posterior ones. The median furrows do not run out on the palpebral lobes as is usual in the genus.

The palpebral lobes are very large, semicircular in outline, and extend so far back that the posterior edges overhang the nuchal segment. The latter is wide, set off by a narrow but distinct furrow.

The facial sutures, in front of the eyes, turn slightly outward and then converge, so that the brim is obtusely pointed.

The associated pygidium, which may, of course, not belong with these cranidia, has more divergent spines than usually seen in this genus. The axial lobe is narrow, pointed behind, extending to the reëntrant between two spines at the posterior margin. There are three well-defined rings at the anterior end, and suggestions of two more. The pleural lobes are nearly flat, three pairs of ribs rising above the general surface for short distances. These ribs end in short flat

marginal spines, and between the last two there are two small subsidiary spines, one on either side of the median line. The latter spines appear to be present on one and absent from the other of the two pygidia found.

Measurements: — One of the cranidia is 5.5 mm. long, 4.5 mm. wide at the palpebral lobes, and 4.0 mm. wide where the facial sutures are most divergent in front of the eyes. The palpebral lobes are 2.25 mm. long on another cranidium which is 5.0 mm. long.

A pygidium is 4.25 mm. long, including spines, and 4.00 mm. wide. The axial lobe is 3.00 long and 1.75 mm. wide at the front.

This species differs from all other known Robergias in the breadth of the brim at the anterior end of the glabella and the shallowness of the anterior pairs of glabellar furrows. Another remarkable feature is the row of circular pits on the brim. This of course suggests *Tramoria punctata* Reed (Quart. journ. Geol. soc. London, 1899, **55**, p. 758, pl. 49, fig. 14–16) from County Waterford, Ireland. The row of pits in that species is, however, farther forward than in the present one. The latter, however, departs so widely from the typical Robergia that I should have placed it in Tramoria, had it not been for the total absence of the first two pairs of glabellar furrows in the type of that genus. *Robergia marginalis* appears to stand about half-way between Tramoria and typical Robergia. That Tramoria is a synonym of Apatokephalus, as suggested by Reed in a more recent paper, seems very improbable.

Horizon and Locality: — Three cranidia and two pygidia of this species were found in the lower part of the Lenoir, one mile east of Bluff City, Tenn. Cranidium (M. C. Z. 1,721) is designated as the holotype, and pygidium (M. C. Z. 1,722) as paratype.

Robergia breviceps, sp. nov.

A small form, known from the cranidium only. The glabella differs from that of most species of the genus in that it enlarges slightly toward the front and the anterior end is somewhat abruptly truncated, turning down into a deep narrow furrow which separates the glabella from the narrow flat anterior border. There are only two pairs of furrows, the posterior ones being curved depressions opposite the middle of the palpebral lobes, and the anterior pair deeper oblique sulci which reach the dorsal furrows at the anterior ends of the eyes. The palpebral lobes are very large, one half as long as the cranidium. The surface of the glabella and neck-ring is minutely granulose.

Measurements:— The holotype is 3 mm. long, and 3 mm. wide at the palpebral lobes. One palpebral lobe is 1.5 mm. long. A larger cranidium, which lacks the anterior flattened border, is 5 mm. long.

This species differs from *R. schlotheimi* in having two instead of three pairs of glabellar furrows and in the shape of the anterior end of the glabella. *R. micropthalma* Linnarsson, *R. scanica* Hadding, and *R. barrandei* Etheridge and Nicholson, also have three pairs of furrows.

Horizon and Locality:— Three cranidia of this species were found in the conglomerate on lot 22, concession VI, two miles north of Mystic, Que., in a boulder where they were associated with *Arthrorhachis galba* (Billings) and other trilobites not yet identified. The holotype is M. C. Z. 1,727.

Cyclopygidae, nom. nov.

(*Aeglinidae* Pictet).

Opisthoparia with large glabella, reduced fixed cheeks, eyes occupying nearly the whole of the free cheeks. Thorax with few segments, generally about six; pygidium short, with few traces of segmentation.

In his preliminary notice of the trilobites of Bohemia (1847, p. 34), Barrande described as *Egle rediviva* a very curious animal whose free cheeks were occupied almost exclusively by the numerous lenses of very large eyes. The name Egle was considered by Corda to be an incorrect rendering of Aegle, already in use for a genus of plants. He therefore replaced it by Cyclopyge. Barrande in 1852 admitted that Egle was preoccupied, but proposed Aeglina in preference to Cyclopyge, and that name is in current use. It is, of course, not necessary to give up a name for a genus of animals because it is also in use for a group of plants, but unfortunately, Egle seems to have suggested itself to several taxonomists, for Aegle was used at least three times before 1847 — by Oken for a mollusk in 1815, by Hübner for one of the Lepidoptera in 1816, and by Haan for a crustacean in 1835. The less correct form Egle was itself employed for one of the Diptera by Robineau-Desvoidy in 1830. It is therefore necessary to use Cyclopyge, Corda's type, *Cyclopyge megacephala*, being the same species as Barrande's *Egle rediviva*. Since Aeglina has to disappear, we can no longer use Pictet's family name Aeglinidae, and it may be replaced, as is natural, by Cyclopygidae.

Bohemia is of course the center of development of Cyclopyge, for there are eight species, occurring in the shales at the top and bottom of the Ordovician.

In D—d_1 are: *Cyclopyge speciosa* (Corda) (type of his genus Microparia), *C. prisca* (Barrande), *C. sulcata* (Barrande), *C. princeps* (Barrande), and *C. rediviva* (Barrande). In D—d_5, at the top of the Ordovician, *Cyclopyge speciosa*, *C. sulcata*, and *C. rediviva*, and also *C. gigantea* (Barrande), *C. pachycephala* Corda, and *C. armata* (Barrande) occur.

Examples of six of these species, including the types of *C. princeps* and *C. prisca*, are in M. C. Z., and in studying them one is struck with the fact that although all have very large eyes, there is a certain amount of variation in the size of the eye in proportion to the size of the cephalon. It reaches its maximum in *C. armata*, and the minimum in the associated *C. gigantea*. In several species, especially in *C. gigantea* and *C. sulcata*, there is an appreciable width of fixed cheek behind the eye, and in *C. princeps* the eyes are far apart in front.

Although there is this variation in the size of the eyes, it seems as though the culmination of trilobite eye expanse in *Cyclopyge armata* Barrande and *C. subarmata* Reed should be recognized by allotting to them a generic name of their own. In addition to having the fixed cheeks reduced to a mere vestige, the free cheeks entirely given up to the visual surface and uniting in front, these species have an Ampyx-like frontal spine, and the glabella is marked by two pairs of deeply impressed furrows. Other species have more or less of a development of glabellar furrows, but where the surface is not smooth, there is usually only one pair of furrows well developed in species other than those now referred to the new genus Symphysops.

The genera of the Cyclopygidae are:—

Cyclopyge Corda. Eyes very large, but some remnant of fixed cheek always present behind them. Palpebral lobes narrow, bordering the dorsal furrows. Thorax with six segments. Pygidium short and wide. Type:— *Egle rediviva* Barrande. Ordovician, Bohemia, Scandinavia, and British Isles.

Symphysops, gen. nov. Eyes meeting in front, so as to form a continuous band around sides and front of cephalon. Glabella produced into a spine in front, and marked by two pairs of furrows. Type:— *Aeglina armata* Barrande. Upper Ordovician, Bohemia, and Scotland.

Telephus Barrande. Palpebral lobes separated by convex fixed cheeks from dorsal furrows. Pygidium short and narrow. Type:— *Telephus fractus* Barrande. Ordovician, Bohemia, Scandinavia, British Isles, North America.

Telephus Barrande.

In an interesting paper on this previously obscure genus, Dr. Hadding (Geol. fören. Forhandl, 1913, **35**, p. 25, pl. 1, 2) gives a summary of the important characteristics, as compared with the other long-eyed trilobites, Aeglina and Remopleurides. He came to the conclusion that each of these genera represented a distinct family. Although Aeglina (Cyclopyge) and Remopleurides are rather obviously only distantly related, it seems to be justifiable to put Telephus in the Cyclopygidae. In both Telephus and Cyclopyge the eyes are very large, the glabella is broad, long, and glabellar furrows are modified or absent. The chief difference between the cephala of the two genera is that in Cyclopyge the palpebral lobes adjoin the dorsal furrows, whereas in Telephus the fixed cheek intervenes. Hadding himself agrees that the thorax of Telephus, so far as it is known, offers no difficulties, and that the pygidium, though small in Telephus, is structurally similar to that of Cyclopyge. Hadding's statement that palpebral lobes and fixed cheeks are absent in Aeglina requires some modification. The palpebral lobes are certainly very narrow, but they are present, and the posterior portion of the fixed cheek is visible in well-preserved specimens of most species, and conspicuous in some. I presume in his statement he had reference only to the part of the fixed cheek between the dorsal furrow and the palpebral lobe.

Telephus americanus Billings.

Telephus americanus Billings, Pal. foss. Canada, 1865, **1**, p. 291, fig. 281.
Hadding, Geol. fören. Förhandl., 1913, **35**, p. 41, fig. 1, pl. 1, fig. 11.

Hadding published a new figure of the type of this species and brought out the principal characteristics of the cranidium much better than was done at the time of the original description. With a number of specimens before me I can only again call attention to the highly convex glabella with its pustulose surface and the pair of obscure depressions representing the posterior pair of glabellar furrows. A small pustule takes the place of the nuchal spine possessed by most species of this genus. One of Hadding's most important results was to show that the so-called spines on the front of the cranidium were really only the buttresses at the anterior ends of the eyes.

A number of fragmentary free cheeks from Table Head, Nfld., prove to be entirely similar to the Swedish ones described by Hadding.

Below the visual surface of the eye is a narrow but deep groove, and outside that a thick elevated border. At the angle is the base of a small spine, but in no case does it seem to be preserved.

Horizon and Locality:— Billings's specimens were from division N, Table Head and Pistolet Bay, and division P, Portland Creek, Nfld. Professors Schuchert and Twenhofel collected numerous cranidia and cheeks from zones M_2, N_1, N_2, and N_3, and from the Isolated limestone, all at Table Head, Nfld.

Near the base of the Athens at Saltville, Va., there occur specimens of a large Telephus which is too poorly preserved to be positively identified.

Telephus troedssoni, sp. nov.

Cranidium small, moderately convex, with broad, flaring palpebral lobes which enlarge toward the front. Glabella ovate, tapering considerably toward the front, bearing only one pair of furrows, which are obliquely directed depressions which do not connect with the dorsal furrows. The nuchal ring is wide, and bears a long slender median spine. The specimen is a cast of the exterior, and shows a very fine granular ornamentation on the palpebral lobes.

Measurements:— The cranidium is 4.00 mm. long, and 5.00 mm. wide across the palpebral lobes near the front. The glabella is 2.25 mm. long, and 3.00 mm. wide at the base. The nuchal spine is about 1.25 mm. long.

This species appears to be most closely allied to *Telephus mobergi* Hadding (Geol. fören. Förhandl., 1913, **35**, p. 37, pl. 2, fig. 12–17), agreeing with that species in the possession of one pair of glabellar furrows, which, however, are differently placed, and in having ornamentation only on the palpebral lobes.

T. troedssoni differs from *T. americanus* Billings in that the glabella tapers more rapidly forward, and in possessing a nuchal spine.

Horizon and Locality:— A single cranidium was found by the writer in Athens shale associated with *Nemagraptus gracilis* in a cutting on the railroad two miles northeast of Athens, Tenn. Named for Dr. Gustav Troedsson who was with me when the specimen was found. Holotype (M. C. Z. 1,723).

Styginidae Raymond.

Approximately isopygous Opisthoparia with glabella greatly expanded at the front, anterior portions of the facial sutures widely

divergent, eyes typically very far back. Thorax of nine segments in the typical genus. Pygidium with well-defined, long axial lobe, pleural lobes smooth or with faint furrows.

Stygina Salter. Glabella only faintly outlined, without furrows. Eyes close to posterior margin. Type:— *Stygina latifrons* (Portlock). Ordovician, Scandinavia, and British Isles.

Bronteopsis Nicholson and Etheridge. Glabella strongly outlined, with or without three pairs of furrows. Eyes close to posterior margin. Type:— *Bronteopsis scotica* Nicholson and Etheridge. Ordovician, Sweden, Great Britain, and eastern North America.

Holometopus Angelin. Glabella strongly outlined. Eyes about their own length from the posterior margin. Type:— *Holometopus limbatus* Angelin. Lower Ordovician, Scandinavia, and eastern North America.

Stygina Salter.

This Ordovician genus, found principally in the British Isles, was included under the Asaphidae by Salter (Palaeontogr. soc., 1864, (1866), p. 171, pl. 18) but with the comment that it showed characteristics which made it transitional between "Asaphus" and "Illaenus."

Among the peculiarities of the genus are:— Glabella not strongly outlined but much expanded at the front, extending almost to the anterior margin. Facial sutures far apart at the front. Free cheeks wide. Eyes small and very far back. Thorax with nine unfurrowed segments. Pygidium with ringed axial and smooth pleural lobes.

The presence of nine unfurrowed thoracic segments excludes this genus from the Asaphidae as now restricted, and the form of cephalon and pygidium prevent its assignment to the Illaenidae. The form of glabella, the free cheeks, and position of the eyes, suggest the Goldiidae, but the axial lobe of the pygidium is too long and the pleural lobes too smooth to meet the requirements of that family. For trilobites of this type, with a Goldius-like cephalon and an asaphid-like pygidium, the family Styginidae was erected.

Holometopus Angelin.

When he proposed this genus, Angelin (Pal. Scandinavica, 1854, 1, p. 58, pl. 33) described three species, which he arranged in alphabetical order. Since the first two were described from pygidia only, it is evident that he had in mind the third as the typical form, since his description of the cephalon could have been taken from that one only.

I therefore designate the third species, *Holometopus limbatus*, as the type of the genus.

Holometopus limbatus differs from Stygina in having the glabella strongly raised above the cheeks and in having the eyes farther forward. This is a rare species and I have not seen a specimen. From evidence of allied species I should be inclined to doubt the correctness of the position of the eyes in Angelin's figure, were it not for his definite statement "Oculi modici, semilunares, distincte reticulati, subcentrales."

Holometopus limbatus was found in the Orthoceras limestone (Upper Beekmantown) at Fågelsang, near Lund, in Scania, Sweden. Billings (Pal. foss. Canada, 1862, **1**, p. 95, fig. 85) described a very similar species, *Holometopus angelini*, from the limestone in the upper part of the Lévis, at Point Lévis, Que.

Bronteopsis Nicholson and Etheridge.

Bronteopsis Salter *nomen nudum* (Wyville Thomson Mss.), Palaeontogr. soc., 1864 (1866), p. 143. 1883 (1883), p. 216.

Bronteopsis Nicholson and Etheridge, Mon. Silur. foss. Girvan, 1879, p. 157, pl. 11, 12. Reed, Palaeontogr. soc., 1904, **58**, p. 92, 1914, **68**, p. 26, pl. 4.

This genus was proposed in manuscript by Wyville Thomson for a trilobite from the Girvan district of Scotland, and referred to without reference to any type-species by Salter. It was first published by Nicholson and Etheridge, who described one new species, *Bronteopsis scotica*, which becomes the type.

Bronteopsis is very like Stygina, but has a much more strongly outlined glabella and a shorter pygidium. It differs from Holometopus chiefly in having the eyes farther back, in the position of those of Stygina.

Salter, Nicholson and Etheridge, and Reed, all considered this genus closely allied to Bronteus (Goldius) and have placed the genus in the Bronteidae (Goldiidae). The pygidium is, however, so unlike that of Goldius and both cephalon and pygidium are so like those of Stygina, that Bronteopsis can be much more satisfactorily placed with the latter genus than the former. The Styginidae are however probably more closely allied to the Goldiidae than to the Asaphidae.

Holometopus and Bronteopsis are closely allied and I am not yet sure they should be separated. Since there are, however, two species, *H. limbatus* Angelin and *H. angelini* Billings, which have their eyes a

little farther forward than in Bronteopsis, it may be as well to keep the genera apart. Such a form as *Holometopus nitens* Wiman must certainly be transferred to Bronteopsis.

Bronteopsis scotica Nicholson and Etheridge.

Bronteopsis scotica Nicholson and Etheridge, Mon. Silur. foss. Girvan, 1879, p. 167, pl. 10, fig. 21, 22, pl. 11, fig. 1–4. Reed, Palaeontogr. soc., 1904, **58**, p. 94, pl. 13, fig. 5–13.

A single imperfect cranidium appears to represent this species. It differs from *Bronteopsis gregaria* and agrees with *B. scotica* in having three pairs of glabellar furrows represented by pits, and also has a pair of prominent eye-lines situated unusually far back. The posterior pair of glabellar furrows have the same position and shape as those of *B. scotica*, but are much less deeply impressed.

Measurements: — The cranidium is 10 mm. long; and the anterior portion of the glabella is 7 mm. wide.

Horizon and Locality: — The single cranidium was collected by Professors Schuchert and Dunbar from the Normanskill, one mile from the Dominion Iron and Steel Company's quarries at Agathuna, Newfoundland. The Scottish specimens are found in the Balclatchie group (Llandeilo) of the Girvan district of Scotland.

Bronteopsis gregaria Raymond.

Plate **3**, fig. 12–14.

Bronteopsis gregaria Raymond, Bull. M. C. Z., 1920, **64**, p. 283.
Holometopus angelini Billings (*partim*), Pal. foss. Canada, 1865, **1**, p. 281, *non*, p. 95, fig. 85.

Cranidium much expanded at the front, so that it is wider than long. Glabella convex, prominent, expanded at the anterior end, the width there being equal to about three fourths the length. The glabella tapers rapidly toward the narrowest place, at the neck-ring, and has an obscure median carina on its posterior half. In the dorsal furrows are obscure indications of three pairs of pits, one pair close to the anterior margin and two pairs on the constricted "neck" of the glabella, these being vestigial glabellar furrows. The fixed cheeks form wide flattened bands on either side of the glabella and opposite its narrow part are raised nearly or quite as high as the glabella itself. The neck-ring bears a small median tubercle.

Pygidium approximately semicircular in outline, convex, with a narrow concave border. Axial lobe long, the acutely tapering posterior end continuing, though only faintly raised, to the border. At the anterior end of the axial lobe are three well-defined rings, behind which there are two or three rather obscure ones. The pleural lobes are smooth, except for an anterior rib. The smaller specimens are nearly flat, and the posterior portion of the axial lobe is more clearly defined than in the large ones.

Measurements: — Length cranidium 7.5 mm., width at front 9 mm. Width glabella at front 5.5 mm., at neck-furrow 3.5 mm. Length pygidium 4 mm., width 7.5 mm.

Horizon and Locality: — The types are from the base of the Liberty Hall limestone at Lexington, Va., where the species is common. It is also common at the top of the Holston at the Thomas farm, three miles northeast of Blacksburg, Va., in the Athens at Chatham Hill, on the northern slope of Walker Mountain, north of Marion, Va. A single specimen was found above the middle of the Holston on the Hoge farm, seven miles south of Bland, Bland Co., Va., and another single specimen in the middle Ottosee, seven miles north of Mendota. Specimens from these three localities are in entire agreement. In Tennessee I found it at only one locality, between the Holston and Tellico, in South Knoxville.

In Newfoundland Schuchert and Twenhofel found this species in zones M_2, N_1, and the Isolated limestone, all at Table Head. These specimens differ from the ones described above in having the cranidium a little shorter and broader, the posterior part of the glabella a little wider, and a slightly shorter axial lobe on the pygidium. Specimens nearer these than the other Virginian specimens were collected by Dr. Shuler on the northern side of Walker Mountain, near White Gate, Bland Co., Va.

This species is much more nearly related to *Bronteopsis ardmillanensis* Reed than to the type of the genus. The Scottish species has a slightly different conformation of the fixed cheeks and more traces of ribs on the pleural lobes of the pygidium, but the differences between the two species are small. *B. nitens* Wiman, obtained from boulders of the older Chasmops limestone, has a somewhat wider glabella and a more acutely triangular axial lobe on the pygidium. Cotypes (M. C. Z. 1,595–1,597).

Bronteopsis marginata, sp. nov.

This species is closely allied to *B. gregaria*, differing from it in having a broader concave border in front of the glabella, and a less strongly

delimited glabella, which is less constricted toward the back. The pygidium is proportionately shorter.

Measurements: — An imperfect cranidium, the holotype, is 6 mm. long, and the border in front of the glabella 2 mm. wide. A pygidium is 3 mm. long, and 6.5 mm. broad.

Horizon and Locality: — A rare fossil in a boulder in the conglomerate on lot 22, concession VI, two miles north of Mystic, Que., where it is associated with Normanskill fossils. Holotype (M. C. Z. 1,759).

Bathyuridae Walcott.

Bathyurellus Billings.

Bathyurellus is a genus seldom met with, although thirteen species have been described. It is of some interest because it is one of the few genera common to the Beekmantown and Chazy, and found both in conglomerates and in *situ* in Newfoundland, Quebec, and New York.

Billings did not designate a type for the genus, but since he described all parts, and had complete specimens of *B. nitidus* only, it seems entirely proper to select that species as the type.

Bathyurellus abruptus Billings.

Plate **3**, fig. 18.

Bathyurellus abruptus Billings, Pal. foss. Canada, 1865, **1**, p. 263, fig. 247, 250.

Schuchert and Twenhofel collected several cranidia and pygidia of this species near the lobster factory at the head of the bay at Old Port au Choix, Nfld. The cranidium is very readily recognized, because the glabella is long and descends abruptly into the very narrow concave border. The surface markings, consisting of fine cracks arranged concentrically on the glabella, are also characteristic. The palpebral lobes are very large.

One small cranidium has a pair of faint glabellar furrows which reach the dorsal furrows at the anterior ends of the palpebral lobes.

Lying beside one of the pygidia is a long, narrow, oval hypostoma, which probably belongs to this species. The surface is evenly convex, and the maculae but little behind the middle.

The pygidium assigned to this species is a very peculiar one, and there seems to be no evidence that they belong together other than the fact that they occur in the same layers in fairly equal numbers and have similar surface markings.

The anterior lateral angles are truncated, the pygidium is longer

than wide, and is concave only on a small part of each pleural lobe, all characteristics in which this species departs from the typical Bathyurellus. If the pygidium were more convex, it would somewhat suggest that of Hyboaspis, a fact which may throw some light on the relationships of that genus.

Horizon and Locality: — Billings's specimens were from divisions F, G, and H, Port au Choix and Keppel Island, Nfld. Schuchert and Twenhofel obtained it from two zones 3100—2 and 3100—3 at Old Port au Choix, where it occurs in the Beekmantown with *Petigurus nero, P. timon,* and *Bathyurellus marginatus.*

Bathyurellus marginatus Billings.

Bathyurellus marginatus Billings, Pal. foss. Canada, 1865, **1**, p. 264, fig. 248.

This species occurs at the same horizons and in the same localities as the last, but is more rare. Billings had but one cranidium, and Schuchert and Twenhofel found but one, a very small specimen. Pygidia are absolutely unlike those assigned to the associated *B. abruptus,* and are not concave. *Bathyurellus expansus* Billings, from Stanbridge, has a pygidium which is similarly ribbed, but the axial lobe is wider and the surface outside it is largely concave.

Bathyurellus validus Billings.

Bathyurellus validus Billings, Pal. foss. Canada, 1865, **1**, p. 268, fig. 252.

Billings says that the glabella and fixed cheeks of this species are like those of *B. fraternus* and that the genal angles are prolonged in broad flat spines as in *B. formosus.* The genal spines of *B. fraternus* are also broad, but they appear to stand nearly at right angles to the body, and only the narrow brim is approximately flat. The pygidium is similar to that of *B. fraternus,* but lacks the ribs on the pleural lobes.

Horizon and Locality: — The original locality was in division L at Point Rich, Nfld. Schuchert, Twenhofel, and Dunbar found isolated pygidia at Port au Choix, Port Rich, and, the highest point in its range, the Leperditia bed at Port au Port. Hyatt collected a pygidium at the first point north of Port au Port, Nfld.

Bathyurellus nitidus Billings.

Bathyurellus nitidus Billings, Pal. foss. Canada, 1865, **1**, p. 265, fig. 249.

Bathyurellus nitidus, B. formosus, B. fraternus, and *B. validus* are very much alike. *B. nitidus* may be recognized by the fact that, like

B. abruptus, it has a long glabella which reaches the concave border. The glabella is much more pointed than in the former species, and is not nearly so convex, especially at the anterior end. Genal spines are said to be absent. The pygidium is like that of *B. fraternus*, in that it shows two or three pairs of ribs on the pleural lobes, but the axial lobe is somewhat shorter.

Horizon and Locality: — This species has been found only at the type-locality in the pebbles of the conglomerate at Cow Head. Schuchert and Dunbar found only a cranidium and a pygidium.

Bathyurellus formosus Billings.

Bathyurellus formosus Billings, Pal. foss. Canada, 1865, **1**, p. 266, fig. 250.

Bathyurellus formosus has a shorter glabella than *B. nitidus*, and differs from both *B. fraternus* and *B. validus* in that the anterior part of the glabella is more convex, and the dorsal furrows are straight between the eyes. One tiny cephalon, which, with the genal spines, is only 2.5 mm. long, has the same short, elevated glabella, narrow brim, and long genal spines as the adult. Billings states that in this species the eyes are smaller than in *B. nitidus*, but this does not seem to be a constant characteristic. The cranidium of *B. marginatus* has an even narrower brim than *B. formosus*, and a wider cheek-roll in front of the glabella.

Horizon and Locality: — Like the last, this species has been found only in the pebbles of the conglomerates at Cow Head, Nfld. Schuchert and Dunbar collected three cranidia.

Bathyurellus fraternus Billings.

Plate **3**, fig. 19.

Bathyurellus fraternus Billings, Pal. foss. Canada, 1865, **1**, p. 267, fig. 251a, b.

Entire body ovate, broadest at the head, the thorax enclosed by the long genal spines. Cephalon large, broad, evenly convex, with a narrow, concave brim which extends back along the genal spines. The latter are continued nearly or quite to the end of the pygidium. The glabella is elevated but slightly above the general surface, pointed in front, outlined by shallow curved dorsal furrows which bend slightly inward between the eyes. The palpebral lobes are large, slightly convex, but proportionately smaller than in *B. formosus*. The cheeks are wide, and curved abruptly downward from the eyes.

The thorax consists of nine segments. The axial lobe is strongly convex, a little more than one third the total width, and tapers considerably from front to back. The pleural lobes are flat, and, what is most remarkable, turn slightly upward instead of downward at the sides, so that the concavity which is so characteristic a feature of the pygidium extends to the thorax as well.

The segments are very flat, and each bears a shallow median furrow on the outer portion.

The pygidium is nearly semicircular, the axial lobe broad, depressed, convex, the remainder concave. There are four rings on the axial lobe, and three pairs of broad ribs on the pleural lobes, none of them very strongly marked. The under surface, where exfoliated, seems to be coarsely punctate.

Measurements:— The specimen, with the head bent somewhat downward, is 48 mm. long. The cephalon, on the axial line, is 25 mm. long; the thorax 18 mm.; and the pygidium 14 mm. The greatest width of the thorax is at the third segment, where it is 29 mm. wide. The axial lobe is 13 mm. wide at the anterior end of the thorax, and 9 mm. wide at the front of the pygidium. The pygidium is 24 mm. wide at the front; and the axial lobe is 9 mm. long.

Bathyurellus fraternus differs from *B. nitidus* not only in having a less elevated glabella with a cheek-roll between it and the brim, but also in having a much wider axial lobe on the thorax. *B. formosus* has a more convex glabella, and *B. expansus* has a more convex glabella and more ribs on the pygidium.

Bathyurellus validus and *B. fraternus* are almost identical. Billings separated them chiefly because he thought that *B. fraternus* came from an horizon 2,000 feet above that of *B. validus*, but as *B. fraternus* was obtained from pebbles in a conglomerate, that argument has no force. Since *B. validus* is not yet known from entire specimens, and since the two species can be separated by the greater smoothness of the pygidium of the latter, both may for the present be recognized.

Horizon and Locality:— The original specimens were from the pebbles in the conglomerates at Cow Head, Nfld. Schuchert and Dunbar collected a single cranidium there, and Hyatt obtained the entire specimen (M. C. Z. 1,643), described above, on the west side of Gargamella Cove, near the base of the Chazy.

Bathyurellus expansus Billings.

Bathyurellus expansus Billings, Pal. foss. Canada, 1865, **1**, p. 318, fig. 306a, b.

The cranidium of this species closely resembles that of *B. formosus*, as both have a convex glabella and a cheek-roll between the front of it and the concave brim. In *B. expansus*, however, the roll is considerably wider than in the former species. On the pleural lobes of the pygidium there are four pairs of rather distinct broad ribs.

Horizon and Locality:— The original specimens were from lot 20, concession VI, in Stanbridge, Que.; the species is quite common on lot 22 of the same concession. Schuchert and Dunbar found one cranidium in the conglomerate at Cow Head, Nfld.

Bathyurellus brevispinus Raymond.

Bathyurellus brevispinus Raymond, Ann. Carnegie mus., 1905, **3**, p. 337, pl. 10, fig. 13–15. 7th rept. Vermont state geol., 1910, p. 218, pl. 32, fig. 13–15.

This trilobite was described from cephala only, but when collecting at the typical locality recently I found a single cranidium associated with three pygidia which very probably pertain to this species.

Pygidium semicircular, depressed convex, the width of the concave border equal to one third the length. Axial lobe narrow, convex, distinctly raised and outlined at the posterior end. Its surface shows two distinct and two faintly marked rings. The inner moities of the pleural lobes are low, nearly flat-topped, sloping abruptly into the flat border. There are three pairs of broad ribs beside the half ribs at the front, so that the whole surface, except directly back of the axial lobes, is involved.

In the original description this species was compared with *Bathyurellus formosus*. The pygidium of that species is not yet known. So far as can be judged from the present material, *B. brevispinus* would appear to be intermediate in characteristics between *B. fraternus* and *B. expansus*, having the pygidium more strongly ribbed than the former and less so than the latter.

Measurements:— The largest pygidium is 6 mm. long, 12 mm. wide; and the axial lobe is 4 mm. long. The smallest is 3 mm. long, and has more sharply marked rings and ribs and a slightly narrower border than the large specimen.

Horizon and Locality:— All the specimens so far collected have come from the reef at the base of the Upper Chazy in a pasture three miles southeast of Chazy, N. Y., near Little Monty Bay.

Bathyurellus glensaulensis Reed.

Bathyurellus glensaulensis Reed, Quart. journ. Geol. soc. London, 1910, **66**, p. 274, pl. 21, fig. 1a–3b.

This, the only extra-American species yet described, is most closely allied to *B. expansus* so far as can be determined from the known characteristics of the two species. The Irish form combines a very wide cheek-roll with a relatively short and prominent glabella. The genal spines are short like those of *Bathyurellus brevispinus* Raymond, but the latter species has a narrow cheek-roll, like *B. formosus*.

Horizon and Locality:— This species has been found only in a calcareous ash on the Glensaul River, near Garranagerra, County Galway, Ireland.

Asaphidae Emmrich.

Ogygiocariniae Raymond.

Niobe quadraticaudata (Billings).

Plate **3**, fig. 20. Plate **6**, fig. 13.

Asaphus quadraticaudatus Billings, Pal. foss. Canada, 1865, **1**, p. 272, fig. 258.
Asaphus morrisi Billings (*partim*), Ibidem, p. 272, fig. 257.

Billings knew only the pygidium of this species, but collected also specimens of the hypostoma, which he supposed to belong to his "*Asaphus*" *morrisi*. Professors Schuchert and Twenhofel collected, among other specimens, one nearly complete, which shows clearly that this is a Niobe.

Entire test elongate, subrectangular, tapering but little.

Cephalon longer than thorax or pygidium, uniformly convex, highest along the median line of the glabella. Glabella large, long, smoothly convex, without furrows. It is nearly parallel-sided, but expands a little in front of the eyes. At the base is a pair of long lunate elevations. The eyes are situated close to the glabella, from which the palpebral lobes are hardly separated. They are well forward, as usual in the genus, a trifle more than their own length from the posterior border. At the horizon of the posterior ends of the eyes there is a small median pustule. Some exfoliated specimens show traces of three pairs of glabellar furrows. Free cheeks wide, striated, the outer part of the slope concave. Just below the visual surface of the eye is a narrow concentric step-like fold of the shell, which is so peculiar as to make

detached free cheeks readily recognizable. In front of the glabella the border is somewhat convex and the anterior margin curved downward.

The entire surface of the cephalon, but more especially the glabella, is covered with wavy cracks and elevated lines, and very numerous large and small puncta.

Thorax of eight segments. Axial lobe a little more than one third of the total width. Pleural lobes with narrow diagonal furrows. The segments are ornamented with numerous cracks and small puncta arranged parallel to the axis of the animal.

Outline of the pygidium suggestive of quadrangularity, but smoothly rounded. Axial lobe wide, gently convex. Pleural lobes depressed convex, with wide concave border. The axial lobe has a single ring and the pleural lobes a single pair of ribs. The ornamentation consists of numerous irregular cracks arranged more or less parallel to the outer margin.

The specimens of this species are accompanied by a number of hypostomata which are evidently the same as described by Billings as the hypostoma of *Asaphus morrisi*. These not only show by their form that they belong to Niobe, but their surface markings prove that they belong to the species now under discussion. The hypostoma is long, rudely rectangular, the surface slightly convex, and the narrow wings expand forward. The posterior margin has a shallow notch, forming two short broad lobes. In front of the notch is a deep transverse furrow, and in front of that a pair of deep maculae. Surface covered with deep, somewhat irregular, transverse cracks.

Measurements: — Length of entire specimen about 65 mm.; width at genal angles 35 mm.; length cephalon, about 23 mm.; length thorax 21 mm.; width axial lobe at front 13 mm.; length pygidium 21 mm., width at front 29 mm.; width axial lobe at front 11 mm. Eye 6 mm. long. Back of eye 7 mm. from posterior margin of head. A larger cranidium is 31 mm. long. The glabella is 16 mm. wide at the neck-ring, 20 mm. wide in front of the eyes and the border in front of the glabella is 3 mm. wide. An hypostoma is 14 mm. long, and 11 mm. in greatest width, near the posterior end. A larger hypostoma is 19 mm. long, and 17 mm. wide.

Niobe laeviceps Angelin is a species which has the pygidium as smooth as that of the form just described, but both cephalon and pygidium are shorter. *Niobe lindströmi* Schmidt has a cephalon very like that of *N. quadraticaudata*, and the pygidium is nearly as smooth, but has several rings on the lobe and it lacks the characteristic surface markings. Most other species of Niobe have ribs on the pygidium.

This Newfoundlandian species is, so far as I can learn, the last survivor of the genus.

Typically a basal Ordovician genus, species of Niobe are found in the Ceratopyge "Region" of Sweden and Norway, the Tremadoc of Great Britain and France, the Orthoceras limestone, "Regio C" of Scandinavia, and the equivalent beds in Russia. It has not been reported in any of these countries from strata younger than the American Beekmantown.

Horizon and Locality: — Billings's original specimens were from division N, Table Head, and the conglomerates of P, four miles northeast of Portland Creek, Nfld. Professors Schuchert and Twenhofel found it a common fossil in their zones M_2, N_1, and the Isolated limestone at Table Head, and also obtained one specimen from zone N_2 at the same locality. All these localities are in strata of Normanskill age.

Niobe morrisi (Billings).

Plate 6, fig. 10.

Asaphus morrisii Billings (*partim*), Pal. foss. Canada, 1865, **1**, p. 272, fig. 257.

Approaching the subject from an American viewpoint, I had supposed *Asaphus morrisi*, of which pygidia only are surely known, to be a Basilicus, but the study of specimens collected by Schuchert and Twenhofel convinces me that it is really a Niobe of the type of *N. emarginula* Angelin. Specimens of this species do not appear to be common.

In the absence of more complete material the generic reference is of course in some doubt. The general appearance of the pygidium, with its broad form and ill-defined ribs, is rather that of Niobe than Basilicus.

The axial lobe is broad at the front, tapers regularly and extends back to the posterior margin, though it is but faint where it crosses the concave portion. It usually shows but two well-defined rings and two partially developed ones. One specimen in the present collection shows seven rings, and Billings said there were ten obscure rounded rings on the type. The pleural lobes show four or five pairs of broad, rounded, rather obscure ribs.

The surface markings are striking and characteristic. The whole surface is finely punctate, and also marked by a system of short wavy cracks which approximately parallel the posterior margin. These cracks are absent from the furrows between the ribs and from the dorsal furrows. On the doublure the terrace lines are very strongly developed.

Billings assigned to this species the hypostoma which I have described above as probably belonging to *Niobe quadraticaudata*. It is undoubtedly the hypostoma of a Niobe, but not having seen it in place, there is still some question as to whether Billings may not have been correct in his disposition of it. I have assigned it to the former species, because, first, there can be no doubt but what that species is a true Niobe, and secondly, because I find that hypostoma associated with shields of *N. quadraticaudata* in localities which have not so far produced pygidia of *N. morrisi*. There are, however, indications that some of the cranidia, free cheeks, and hypostomas now referred to *N. quadraticaudata* really belong to *N. morrisi*. For instance, there is one hypostoma from zone N_1, Table Head, which has much less prominent striae than the others. This might belong to *N. morrisi*. Some of the free cheeks from the same locality not only show the rim-like border below the eye but have an elongate tubercle projecting from this rim. And lastly, on the same fragment of rock with a pygidium of *N. morrisi* there is a cranidium which seems to have a broader glabella and longer and larger basal glabellar lobes than *N. quadraticaudata*. The surface ornamentation is almost exactly the same as on the pygidia of *N. morrisi*, and the surface much more strongly punctate than in the shell which remains on the entire specimen of *N. quadraticaudata*.

From the above, it is evident that more material is necessary for a satisfactory description of this species.

Measurements: — Billings says: "Width of the largest pygidium seen $3\frac{1}{2}$ inches [about 87 mm.]; length $2\frac{1}{4}$ inches [about 56 mm.]." The largest pygidium in the present collection is 65 mm. wide, and 35 mm. long. A better preserved one is 49 mm. wide, and 28 mm. long; the axial lobe is 12 mm. wide.

Horizon and Locality: — Billings reported the species from division N, Table Head, and the conglomerates of P, four miles northeast of Portland Creek, Nfld. Schuchert and Twenhofel collected it only from zone N_1 at Table Head, but there are two pygidia in the M. C. Z. (1,649, 1,650) collected by Professor Hyatt on the east side at Port au Port. All are from the horizon of the Normanskill.

Niobe lineolata, sp. nov.

Plate **3**, fig. 15, 16.

Test small, nearly parallel-sided. Cephalon almost semicircular in outline, the genal angles extended into short but sharp spines. Glabella depressed convex, smooth, nearly parallel-sided, expanding but

little in front of the eyes. Neck-furrow very faintly indicated on the median lobe. Just ahead of it is a minute median pustule. No traces of glabellar furrows. Eyes very large, nearly one half the whole length of the cephalon. Facial suture marginal in front. A narrow flat border extends around the front of the glabella. The posterior end of the hypostoma is rounded, but details cannot be made out. Thoracic segments short, axial lobe elevated above the pleural lobes, narrow, less than one third the total width.

Pygidium semicircular in outline, with a narrow concave border. Axial lobe prominent, tapering regularly backward to a point at the posterior margin, depressed and faint where it crosses the concave border. On it are four to eight faintly defined rings. The pleural lobes show four pairs of rounded ribs which extend down onto the concave portion.

The surface on all parts is covered with very fine raised wavy lines.

Measurements: — Length of a nearly complete specimen 20 mm.; width at front of thorax 14 mm., length of thorax 7 mm.; length of pygidium 7 mm., width 14 mm. Length of another cephalon 6 mm., width 12 mm.

A specimen from Port au Port is 21 mm. long, and 13.5 mm. wide. The cranidium is 8 mm.; the thorax 6 mm.; and the pygidium 7 mm. long. A large pygidium is 10.5 mm. long, and 19 mm. wide.

Horizon and Locality: — This species is most common at Port au Port where Schuchert and Twenhofel collected it in their zone 6 (Normanskill) and where Professor Hyatt also obtained a large number of specimens. Professor Hyatt obtained it also from the same horizon on the south side of St. John Island. There is a single pygidium in the Yale collection from zone N_1 at Table Head, and there are several cephala, pygidia, and incomplete specimens from zone N_2 at the same locality. A few specimens were also obtained from the Normanskill near the quarry of the Dominion Iron and Steel Company at Agathuna, Nfld., by Schuchert and Dunbar.

The holotype and figured paratype are in the Yale University Museum. Two other paratypes are M. C. Z. 1,760 and 1,761.

Megalaspis huttoni (Billings).

Plate 6, fig. 11.

Asaphus huttoni Billings, Pal. foss. Canada, 1865, **1**, p. 271, fig. 256.

I was at one time of the opinion that the specimens designated as *Asaphus huttoni* were only the young of *A. morrisi* (see Bassler, Bull.

92, U. S. N. M., 1915, p. 102), but with more material it appears that they are not only a distinct species, but belong to a different genus. The generic reference depends upon: — First, the divided ribs on the pleural lobes of the pygidium; secondly, the similarity to *Megalaspis pagiata* Tornquist; and lastly, the form of the cranidium.

Cranidium narrow, pointed in front. Glabella depressed convex, very narrow between the eyes, expanding in front, definitely outlined. Just in front of the ill-defined neck-furrow is a prominent median pustule. Eyes small, elevated, situated well back of the middle. Fixed cheeks small. Free cheeks and hypostoma unknown.

Pygidium rounded in outline, more than one half as long as wide. Surface rather evenly convex, axial lobe narrow and long, concave border narrow. On the axial lobe there are, according to the state of preservation, from one to fourteen indistinct rings. On the pleural lobes are six to twelve pairs of broad rather indistinct grooved ribs which merge into the general surface on the outer parts of the lobes.

This species is exceedingly like the Swedish and Norwegian *M. pagiata*, differing from it in having the pygidium a trifle more elongate and the ribs a little more distinct.

Megalaspis pagiata occurs in the middle of the Lower Dicellograptus beds in Jemtland, Sweden, and in zone 4a, (Ogygia shale), in the Mjosen district in Norway.

Measurements:— Billings's type, a pygidium, was 5 lines (10 mm.) long, and 7 lines (14 mm.) wide. A small pygidium in the present collection is 11.5 mm. long, and 17 mm. wide. A large one is 43 mm. long, and 50 mm. wide. The largest specimen, which is considerably flattened, is 50 mm. long, and 78 mm. wide.

Horizon and Locality:— Billings reported his specimens from division N, Table Head, Nfld. Professors Schuchert and Twenhofel seem to have found but nine specimens, two in zone N_1 at Table Head, five in zone N_2 at the same locality, and two in zone 6 at Port au Port, Nfld., all in the Normanskill.

Xenostegium Walcott.

Xenostegium Walcott, Smith. misc. coll., 1924, **75**, no. 2, p. 60, pl. 13, fig. 5.

Walcott has suggested this generic name for some of the species which have been referred to Megalaspis by American authors. The generic diagnosis, "Xenostegium contains many species, some of which were formerly referred to Megalaspis. It is characterized by the spined pygidium" leaves much to be inferred from the sketchy

outline figures. The genotype is *Asaphus* (*Megalaspis ?*) *goniocercus* Meek, a species hitherto known from pygidia. Walcott figures a cranidium, which, if correctly assigned to this species, indicates the necessity for the new generic name. Basing the separation on the characteristics of the cranidia, Xenostegium differs from Megalaspis in lacking the dorsal furrows, so that the glabella is not delimited, and in having the facial sutures reach the anterior border at the sides instead of meeting at an acute angle on the median line. It is not obvious how the cranidium differs from that of Hemigyraspis, which occurs at the same horizon and localities as Xenostegium.

Xenostegium shepardi (Raymond).

Plate **3**, fig. 21.

Megalaspis shepardi Raymond, Amer. journ. sci., 1922, ser. 5, **3**, p. 204.

Cephalon and thorax unknown.

Pygidium elongate, subtriangular, pointed behind. Axial lobe clearly outlined by the dorsal furrows, but not elevated above the general surface; it is contracted near the middle, but as the dorsal furrows do not unite behind it, it persists as a median ridge to the posterior extremity. There are six faintly defined rings on the anterior half. Pleural lobes smooth, except for the anterior half rib, and an obscurely defined pair just behind it. The shell has numerous, irregularly scattered, puncta.

Two other species of this type have been described from western North America: — *X. belemnurus* (White) and *X. goniocercum* (Meek). The former is the better known, since it has been figured (Rept. U.S. geol. surv. west 100th mer., 1877, **4**, p. 59, pl. 3, fig. 9). So far as can be judged from the figure and description, *X. shepardi* differs from this species chiefly in the contraction of the middle portion of the axial lobe, and in having less distinct transverse furrows on both axial and pleural lobes. It is also proportionally longer and narrower, as shown by the measurements. *X. goniocercum* is described as almost entirely destitute of dorsal furrows, and the axial lobe is said to fade out posteriorly before reaching the posterior end. It is also wider than long, and thus not so slender as *X. shepardi*.

Measurements:— The pygidium, which is the holotype (M. C. Z. 1,685), is 36 mm. long, and 36 mm. in width. The axial lobe is 10 mm. wide at the front and 6 mm. at the narrowest place. White states that a pygidium of *X. belemnurus* was 15 mm. long to the base

of the caudal spine [should add only 1 or 2 mm. to complete, according to the figure], and 22 mm. wide. Meek gives the dimensions of a pygidium as: length .74 inch (18.5 mm.), width .94 inch (23.5 mm.).

Horizon and Locality:— The holotype was collected from the Lower Ordovician limestone one eighth mile above the entrance to Sinclair Canyon, northeast of Lake Windermere, B. C., by Mrs. Francis P. Shepard.

Hemigyraspis mcconnelli Raymond.

Plate 3, fig. 22.

Hemigyraspis mcconnelli Raymond, Bull. 1, Victoria mem. mus., 1913, p. 41, pl. 4, fig. 4.

This species was described from an entire but more or less damaged specimen. A pygidium collected by Dr. Francis P. Shepard in some measure supplements the original, and is herewith described and figured.

Pygidium almost semicircular, a little more than twice as wide as long. Surface depressed convex, with a narrow concave border. Axial lobe gently convex, a little less than one third the total width at the front, tapering rapidly posteriorly. When exfoliated it shows four poorly defined rings which are probably very inconspicuous in specimens retaining the test. The pleural lobes show only the faintest traces of furrows.

This species is seemingly very closely allied to *H. collicana*, which I described (Ann. Carnegie mus., 1910, 7, p. 41, pl. 14, fig. 9–13) from the Lowest Ordovician (Ceratopyge zone) of central Pennsylvania. It differs chiefly in having a wider and less distinctly segmented axial lobe.

Horizon and Locality:— The original specimen of this species was obtained near Golden, B. C., and the one here figured (M. C. Z. 1,680) was collected by Dr. F. P. Shepard in a continuation of the same strata (Lowest Ordovician) in Sinclair Canyon, near Lake Windermere, southeast of Golden..

Nileus macrops Billings.

Nileus macrops Billings, Pal. foss. Canada, 1865, 1, p. 274, fig. 259.

Billings stated that *Nileus macrops* differed from *N. scrutator* in having the eye much larger. Although this single characteristic suffices to distinguish some of the more typical specimens, it should be

pointed out that a more useful difference is that in *N. macrops* the cranidium is proportionately much longer and narrower than in *N. scrutator*, and the specimens are usually of much smaller size. The median tubercle is, in this species, located almost in the middle of the head, whereas in *N. scrutator* it is back on a line with the posterior ends of the eyes.

Measurements: — A large cranidium from N_1 is 21 mm. long, and 23 mm. wide at the palpebral lobes. A smaller one is 10 mm. long, and 12 mm. wide.

Horizon and Locality: — This species is reported by Billings from division N, Table Head, Nfld. Professors Schuchert and Twenhofel collected one large cranidium from zone M_1, Table Head, and several smaller ones from zones M_2, N_1, N_2, and the Isolated limestone, all at the same locality. It does not appear to be so common as *N. scrutator*. I have seen it only from Newfoundland, and in the conglomerate on lot 22, concession VI, two miles north of Mystic, Que.

Nileus scrutator Billings.

Plate **3**, fig. 17.

Nileus scrutator Billings, Pal. foss. Canada, 1865, **1**, p. 274, fig. 260.

This species is more common and is a larger species than the last. Although Billings figured only an imperfect cephalon, he described the pygidium and mentioned a couple of obscurely preserved complete specimens. That seven is the usual number of segments in the thorax is shown by the fact that this is the number present both in Billings's specimens and an entire one collected by Dr. R. M. Field near Saltville, Va.

At the Thomas farm, near Blacksburg, Va., where this species is fairly common, I found a single hypostoma. It is transversely oval in outline, the gently convex body flanked by broad flat wings. The posterior border is slightly concave, the curvature interrupted by a short angular median projection.

Measurements: — A large cranidium from zone N_2, Table Head, Nfld., is 25 mm. long, and 35 mm. wide at the palpebral lobes. A pygidium from the same locality is 15 mm. long, and 31 mm. wide. A cranidium from Chatham Hill, Va., is 12.5 mm. long, and 19 mm. wide at the palpebral lobes. A pygidium from the same place is 8.5 mm. long, and 16 mm. wide. The entire specimen from near Saltville, Va., is 35 mm. long; the cephalon 12 mm.; the thorax 10 mm.; and the

pygidium 13 mm. long. The hypostoma from near Blacksburg, Va., is 6.5 mm. long, and 9.5 mm. wide.

Horizon and Locality: — Billings recorded the species from division N at Table Head, and the conglomerates of P at Portland Creek, Nfld. Professors Schuchert and Twenhofel collected it in the following zones at Table Head, Nfld: — Leperditia bed, their locality 3,100—14, one specimen, zone M_1, one specimen, zone M_2, five specimens, zone N_1, one specimen, zone N_2, thirteen specimens. It is also found at Port au Port, specimens from this locality being present in the collections of both Yale and the M. C. Z.

It occurs in the Athens at the quarries east of Saltville, Va., at Chatham Hill, on the northern side of Walker Mountain, north of Marion, Va., and in the middle and upper Athens at Bullsgap, Tenn. It is rather common at the top of the Holston at the Thomas farm, three miles northeast of Blacksburg, Va. Specimens have also been obtained from boulders in the conglomerate on lot 22, concession VI, two miles north of Mystic, Que.

Asaphinae Raymond.

Basilicus laeviculus, sp. nov.

Plate **4**, fig. 15, 16. Plate **6**, fig. 15.

Curiously enough Basilicus is very poorly represented in the southern Appalachians and I have seen so far only one fragmentary cranidium, one free cheek, one hypostoma, and one pygidium, all from Bland County, Va. Although there is no positive evidence that these are all fragments of one species, they will for the present be so regarded, since all occur at about the same horizon.

The anterior end of the cranidium is broken away, but it was apparently short and wide. The glabella is not very definitely outlined, but is somewhat elevated and was evidently considerably higher than the border at the front. There are practically no traces of glabellar furrows, but faint lateral lobes can be made out back of the eyes. The neck-furrow is also nearly obsolete. The eyes are large, situated far back, and the palpebral lobes are flat. In front of the eyes the facial sutures turn abruptly outward and the glabella likewise expands. The free cheek is broad and shows a short flat genal spine. The hypostoma is large, rather smooth for this genus, with deep maculae and long pointed forks.

The pygidium is short and smooth for the genus. It is gently con-

vex, with a wide smooth axial lobe, and the pleural lobes show four pairs of short, faint, smoothly rounded ribs. The border is wide, rather steep, and gently concave. The ribs do not cross it, and although the axial lobe and the upper parts of the pleural lobes are practically smooth, the concave border is crossed by fine wavy cracks which follow a course nearly at right angles to the axis.

Measurements: — The cranidium is too fragmentary to give any satisfactory measurements, but was probably about 55 mm. long, and 60 mm. wide at the widest part in front of the eyes. The hypostoma is about 37 mm. long, and 38 mm. wide. The pygidium is 61 mm. long, and 86 mm. wide.

This species is not particularly like either *Basilicus barrandi* (Hall) or *B. marginalis* (Hall), the two American species of the genus, being much smoother than either, and the same remark applies to all the British forms except *B. powisi* (Murchison), a Caradoc form which seems closely allied. The cephala of *B. laeviculus* and *B. powisi* agree in lacking glabellar furrows, in the abrupt outward turn of the sutures in front of the eyes, and in that the cheeks have very short spines. The pygidia of the American form are smoother than the British ones for they show no rings on the axial lobes and have only four instead of eight or nine pairs of obscure ribs.

Horizon and Locality: — A rare species found so far only in the middle of the Holston in the McNutt quarry at Sharon Springs, in Bland Co., Va. The cranidium was collected by Dr. E. W. Shuler; the remainder of the specimens by the writer. Cotypes (M. C. Z. 1,634–1,638).

Homotelus Raymond.

Homotelus Raymond, Bull. M. C. Z., 1920, **64**, p. 285.
Onchometopus Raymond and Narraway, *non* Schmidt.
Isotelus (*partim*) of authors.

The generic name Onchometopus was first applied (Ann. Carnegie mus., 1910, **7**, no. 1, p. 51; Raymond, Ibidem, p. 63) to an American trilobite by Raymond and Narraway in describing a new species from the Middle Ordovician of Minnesota and Pennsylvania. The essential features of the trilobites for which this name has been used are the isoteliform glabella and sutures, but asaphiform lack of concave borders on the shields. Since my attention was first directed to this combination of characteristics, wider experience has shown that they form a large group in the Middle and Upper Ordovician and that although similar to the Russian Onchometopus they are probably not

congeneric with it. The two genera form one more example of that parallelism among the Asaphidae to which I have already called attention (Proc. trans. Royal soc. Canada, 1912, ser. 3, **5**, sect. 4, p. 111). Detailed study with large numbers of specimens indicates that Onchometopus is a derivative of Asaphus, while Homotelus sprang from Isotelus, not once merely, but probably several times. Homotelus differs from Isotelus chiefly in lacking the concave borders on the shields. Often specimens are found in which concave borders are feebly or sometimes even well developed, indicating that this characteristic is one of suppression and showing readily how a Homotelus could have been evolved time after time from various species of Isotelus. Homotelus cannot then be regarded in a strict sense as a good genus, but is a convenient term for a number of species showing similar characteristics.

At the time of our first use of Onchometopus, Mr. Narraway and I pointed out that the American species which we referred to the genus did not have the peculiar hooked doublure which Schmidt considered the most important feature. In 1914 it was my privilege, aided by the Shaler Memorial fund, to collect Onchometopus from the typical localities south of Lake Ladoga, and direct comparison of specimens is now possible. Cephala of American and Russian forms are exceedingly alike in smoothness of glabella, position of eyes, course of facial sutures, and shape of fixed and free cheeks. Doublures are strikingly different not only in the hooked and furrowed character of that of the Russian form, but also in its narrowness. Greater differences are seen in the thorax, where Onchometopus shows the high narrow ring of an Asaphus, while the Homotelus has the broader and flattened rings of the Isotelus. The pygidia again are similar, but that of Onchometopus is generally shorter and more nearly semicircular.

As the type of Homotelus I selected a species from the Eden of the region of Cincinnati, chosen because of the excellent material available, and named it *Homotelus ulrichi* for Dr. E. O. Ulrich of the U. S. Geological Survey.

Homotelus ulrichi Raymond.

Plate **6**, fig. 3–5.

Homotelus ulrichi Raymond, Bull. M. C. Z., 1920, **64**, p. 287.

Outline of entire animal oval, whole surface rather evenly convex, the eyes being the only conspicuous prominences. Cephalon and pygidium about equal.

Cephalon twice as wide as long, nearly semicircular, but since the outline comes just within the semicircle, passing through the anterior point and genal angles, there is a suggestion of triangularity. The glabella is smooth, not differentiated. On an occasional specimen there are two pairs of pits between the eyes, the vestiges of two pairs of glabellar furrows. The neck-furrow is practically obsolete and just in front of its normal position is a very small median pustule. The dorsal furrows are very faint except on crushed specimens. The eyes are small, strongly elevated and far apart. The palpebral lobes are small, concave on top and so short that a part of the visual surface looks upward. The genal angles are rounded and the sides of the cheeks have a narrow flattened and striated border which stands at an angle with the general surface and is turned downward at the sides and front. This joins the nearly horizontal doublure in a sharp edge.

Axial lobe of thorax wide, but less than one half the entire width.

Pygidium not quite twice as wide as long, the narrow axial lobe faintly but definitely outlined, most prominent at the posterior end. Pleural lobes smooth.

Measurements:— The entire specimen selected as the type is 58 mm. long, and 33 mm. wide at the genal angles. The cephalon is 18.5 mm. long; the eye 5 mm. long, and the back of the eye 6 mm. from the posterior margin of the head. The thorax is 20 mm. long, 32 mm. wide at front, and 32 mm. wide at back. The axial lobe is 15 mm. wide at front, and 13.5 mm. wide at back. The pygidium is 19.5 mm. long, 32 mm. wide at the front. The axial lobe is 15 mm. long.

Homotelus obtusus (Hall) of the Chazy differs from this species in having more strongly impressed furrows and particularly in its very conspicuously punctate shell. *Homotelus simplex* (Narraway and Raymond) is much more closely like the present one but has the eyes larger and farther back, more traces of ribs on the pygidium, and lacks the angulated border on the cephalon.

Horizon and Locality:— This species seems to be quite common in the Eden in the vicinity of Cincinnati, Ohio, but as the specimens are all in the Dyer collection I have no data on either exact horizon or locality. Cotypes (M. C. Z. 1,575, 1,576).

Homotelus elongatus Raymond.

Plate **4**, fig. 1–3.

Homotelus elongatus Raymond, Bull. M. C. Z., 1920, **64**, p. 288.

Onchometopus simplex Bassler (*non* Raymond and Narraway), Maryland geol. surv. Cambrian and Ordovician, 1919, p. 348, pl. 47, fig. 11.

Test large for the genus, elongate, both shields subtriangular, strongly convex. Cephalon subtriangular, less than twice as wide as long, evenly convex. Glabella smooth, not outlined, dorsal furrows present only back of the eyes and glabellar furrows obsolete. Eyes prominent, situated a little back of the middle but more than their length ahead of the posterior margin. Genal angles rounded.

Thorax abruptly deflected at the sides, depressed convex on top. Axial lobe less than one half the total width.

Pygidium triangular, strongly and evenly convex, the axial lobe hardly outlined except at the posterior end. Exfoliated specimens show traces of several ribs on the pleural lobes.

Measurements:— One entire, but much damaged, specimen is about 105 mm. long and 60 mm. wide at the genal angles. A well-preserved pygidium is 44 mm. long, and 63 mm. wide. A smaller one is 36 mm. long, and 51 mm. wide.

This species is readily recognized by its highly convex triangular shields. The axial lobe of the pygidium is also less strongly defined than in most other species.

Horizon and Locality:— A very common species in the lower Echinosphaerites zone of the Chambersburg in the vicinity of Chambersburg and Marion, Pa. and Strasburg, Va. Bassler reports it from the Nidulites zone of the Chambersburg at Wilson, Md. Cotypes (M. C. Z. 1,577–1,579).

Homotelus indentus Raymond.

Plate **4**, fig. 6. Plate **5**, fig. 7. Plate **9**, fig. 2.

Homotelus indentus Raymond, Bull. M. C. Z., 1920, **64**, p. 288.

This species is so far represented only by pygidia, but these differ obviously from the majority of species of the genus in their more elongate form and the upturned posterior border. The axial lobe is long, narrow, gently tapering, and prominent. The pleural lobes ribless, evenly convex. Back of the axial lobe the posterior margin is upturned, so that in this region there is a concave border. This upward tilt in the posterior margin suggests a somewhat pointed cephalon. The surface of the test is covered with small flat-bottomed circular depressions which are arranged about as closely together as they can be and still retain their circular shape. They appear to be very large, but superficial puncta. Along the borders these are less numerous, and among them are numbers of short wavy cracks

roughly parallel to the margin. Exfoliated specimens, of course, show no trace of this ornamentation, but do show faint traces of ribs on the pleural lobes.

Measurements: — The largest pygidium is 43 mm. long, and 57 mm. wide. The axial lobe is 35 mm. long, and 17 mm. wide at the front. A second specimen is 33 mm. long, and 45 mm. wide. The ratio of length to width indicates the elongation of the pygidium in this species. This index in *H. ulrichi*, which is more like *H. indentus* than any other described species, is about 610, in *H. obtusus* it is 655–680, in *H. elongatus*, which has a long pygidium, it is about 700, whereas in the largest specimen of *H. indentus* it is 754.

Aside from the length of the pygidium and the upturned posterior margin, the character of the ornamentation serves to identify this species.

Horizon and Locality: — This seems to be a rather rare species, found so far only in the Holston in the Catawba Valley, north of Salem, and on the Hoge farm, nine miles southwest of Bland, Va. The specimens from this latter locality were collected by Dr. E. W. Shuler. Cotypes (M. C. Z. 1,580, 1,581).

Homotelus obtusus (Hall).

Plate **4**, fig. 7, 8.

Asaphus ? obtusus Hall, Pal. N. Y., 1847, **1**, p. 24, pl. 4 (*bis*), fig. 14.
Onchometopus obtusus Raymond, 7th rept. Vermont state geol., 1910, p. 22, pl. 34, fig. 1, 2, pl. 38, fig. 2–4. Bassler, Bull. 92, U. S. N. M., 1915, p. 873.

This species, or one exceedingly closely allied to it, is very abundant at the top of the Holston at the Thomas farm, three miles northeast of Blacksburg, Va. All the specimens are dissociated pieces: — cranidia, free cheeks, hypostomata, thoracic segments, and pygidia. The specimens agree with *H. obtusus* in having the eyes farther back than in other species of the genus, in the short, rounded form of the pygidium, the faintness of the axial lobe on the abdominal shield, and more particularly in the presence of numerous large puncta on the test. The puncta are not, however, as prominent as in the typical specimens.

Measurements: — A cranidium 17 mm. long indicates that the eye was 5 mm. long and the posterior margin of it 3.5 mm. from the posterior edge of the cephalon. A large pygidium is 21 mm. long, and 32 mm. wide. A pygidium of *H. obtusus* from Valcour Island, N. Y., is 17 mm.

long, and 25 mm. wide. The ratio of length to width is very nearly the same, the index being 656 in one case and 680 in the other.

Horizon and Locality: — In the typical region in Vermont and New York, *Homotelus obtusus* is most common in the upper part of the Chazy. In Virginia it is very abundant in the top of the Holston on the Thomas farm, three miles northeast of Blacksburg, and occurs also in the upper part of the Holston in the Catawba Valley, north of Salem, and at the base of the Liberty Hall at Lexington, Va.

Homotelus laevis Raymond.

Plate **9**, fig. 3, 4.

Homotelus laevis Raymond, Bull. M. C. Z., 1920, **64**, p. 289.

This name is suggested for a species, the pygidia of which are common and of which a few fragmentary cranidia and free cheeks have been seen. In general outline and proportions the pygidium is most like that of *H. obtusus*, but the axial lobe is more strongly developed and the puncta are much fewer, finer, and farther apart. There is also a faint concave border on the posterior part. The cranidium is very slightly convex, the eyes large and well back. The cephalon is in fact much more typically isoteliform than that of any other species. Exfoliated or compressed specimens show rather plainly the ribs of the pygidium.

Measurements: — A small pygidium is 22 mm. long, and about 35 mm. wide. The axial lobe is 16 mm. long, and 11 mm. wide at the front. A large specimen (flattened) is 45 mm. long, and about 70 mm. wide.

Horizon and Locality: — This species is exceedingly common in the Athens at Chatham Hill, on the northern slope of Walker Mountain, north of Marion, Va. It is also found in the same formation near White Gate and Tilsons Gap, Bland Co., and in the Holston near McDonalds Mills in the Catawba Valley, north of Salem, Va., in all of which localities it was collected by Dr. E. W. Shuler; and also in the Holston at the McNutt quarry, Sharon Springs, Va. A single large pygidium collected by the writer in the Athens near Saltville, Va., is probably of this same species. In the lower part of the Athens near Bullsgap, Tenn., the species is quite common. Holotype (M. C. Z. 1,600); paratype (M. C. Z. 1,607).

Homotelus laeviurus Raymond.

Plate **4**, fig. 4, 5.

Homotelus laeviurus Raymond, Bull. M. C. Z., 1920, **64**, p. 290.

This species has a short broad cranidium, of little convexity, on which the glabella is entirely merged into the general surface, and dorsal and glabellar furrows quite absent. The median pustule is small, but prominent on the otherwise smooth surface, and the shell seems devoid of puncta. The free cheeks and thorax are unknown.

The pygidium is evenly convex and the only marking is a very slight swelling indicating the position of the posterior end of the axial lobe. Even in internal casts the outline of the axial lobe shows only vaguely.

Measurements: — A cranidium is 17 mm. long, and 24 mm. wide at the tips of the fixed cheeks. At the widest point in front of the eyes it is 16 mm. wide. Another cranidium is 11.5 mm. long, 16 mm. wide at the tips of the fixed cheeks, and 9.5 mm. wide at the palpebral lobes. A pygidium is 14 mm. long, and 19 mm. wide.

This species is more nearly allied to *Homotelus simplex* Raymond and Narraway than to any other described species, but has smoother shields, and the pygidium in particular shows less trace of the axial lobe. The absence of puncta in the shell separate it from *H. obtusus*, the only other species with which it could be confused.

Horizon and Locality: — A very common trilobite in the Kimmswick limestone at Mincke, Mo., where it was collected by Dr. D. C. Barton. Cotypes (M. C. Z. 1,584, 1,585).

Homotelus catactus Raymond.

Plate **5**, fig. 5.

Homotelus catactus Raymond, Bull. M. C. Z., 1920, **64**, p. 290.

The only representative of this genus so far found on Newfoundland is a single cranidium which does not seem referable to any of the described species.

This specimen indicates a short and wide cephalon which was evenly arched and rather convex for the genus. The glabella is merged completely into the general surface, and both dorsal and glabellar furrows are completely absent. The facial sutures turn far outward in front of the eyes, so that this portion of the cranidium is wider than in any

other species of the genus. The palpebral lobes are large, indicating very large eyes, and are situated a little more than their own length in front of the posterior margin, but not quite twice their length from the anterior edge. The surface, so far as can be determined from a largely exfoliated specimen, is smooth.

This species differs from any previously described in having larger eyes and in the greater width of the portion of the cranidium in front of them.

Measurements:— Length of cranidium, about 32 mm., width at palpebral lobes 32 mm. Length of palpebral lobe 8 mm., distance from back of palpebral lobe to posterior margin 11 mm.

Horizon and Locality:— The single specimen was collected by Professor Dunbar from a pebble in the Cow Head conglomerate on Stearing Island, Nfld, and is in the Yale University Museum.

Homotelus susae (Whitfield).

Asaphus susae Whitfield, Geol. Wisc., 1882, **4**, p. 236, pl. 5, fig. 3, pl. 10, fig. 8.
Chamberlin, Geol. Wisc., 1883, **1**, p. 160, fig.
Asaphus (*Isotelus*) *susae* Calvin, Iowa geol. surv., 1903, **13**, p. 46.
Not Asaphus, Isotelus, *Onchometopus susae* of Whiteaves, Clarke, and Raymond.

Calvin has pointed out the distinction between the original *Asaphus susae* of the Trenton and the rather similar *Isotelus susae* of the Maquoketa. He says of the former that "It is smaller, more convex, thicker in front than posteriorly, with the anterior part of the head deflected so that near the front margin the surface of the glabella stands nearly at right angles to the general plane of the body — characteristics correctly shown in Whitfield's Figure 8, Plate 10. The eyes are more prominent, the visual surface is larger than in the species figured and described by Clarke, and the posterior limb of the glabella is much narrower in proportion to its length." Calvin was able to compare specimens from the upper part of the Trenton near Florenceville, Howard Co., Iowa, with specimens from the Maquoketa of the same region, so his opinion is given especial weight. He found that the examples from the higher beds agreed with those described by Clarke as *Isotelus susae*, and for this latter species suggested the name *Isotelus florencevillensis*.

Horizon and Locality:— *Homotelus susae*, as restricted, is known only from the upper Trenton at Apple River, Jo Daviess Co., Ill., and at the same horizon near Florenceville, Howard Co., Iowa.

Homotelus florencevillensis (Calvin).

Isotelus susae Clarke, Geol. Minn., 1897, **3**, pt. 2, p. 708, fig. 10, 11.
Isotelus florencevillensis Calvin, Iowa geol. surv., 1903, **13**, p. 46.

Calvin's reasons for distinguishing this species from *Homotelus susae* have been set forth under the preceding caption. Summarized, it may be said that *H. florencevillensis* has a broader and more depressed form, less prominent eyes, a longer and flatter glabella, a longer pygidium, and a less definitely outlined axial lobe on the latter shield than *H. susae*. The species are, however, much alike, and without direct comparison of specimens a separation would probably not have been made.

Horizon and Locality:— This species is so far fully identified only in the Maquoketa at Granger and Spring Valley, Minn., and the vicinity of Florenceville, Howard Co., Iowa.

Homotelus gratiosus Raymond.

Plate **6**, fig. 1, 2.

Homotelus gratiosus Raymond, Bull. M. C. Z., 1920, **64**, p. 291.
Asaphus (Isotelus) susae Whiteaves (*non* Whitfield), Pal. foss. Canada, 1897, **3**, pt. 3, p. 231.
Onchometopus susae Raymond, Proc. and trans. Roy. soc. Canada, 1912, ser. 3, **5**, sect. 4, pl. 2, fig. 1, 2.

Cephalon nearly semicircular, evenly convex, with large, elevated eyes. Cranidium absent from the type, but on other specimens depressed, smooth, glabella not outlined. Fixed cheeks smooth, genal angles rounded. Eyes large, near the middle of the cephalon.

The axial lobe of the thorax is wide for an Homotelus, being nearly one half the total width.

Pygidium short and wide, nearly semicircular, with the axial lobe outlined at the anterior end only.

Measurements:— Length of cephalon 25 mm., width 51 mm.; the eye is 10 mm. long. Total width of thorax at middle 48 mm.; width of axial lobe 23 mm. Length of pygidium 26 mm., width 46 mm.

This species differs from *Homotelus florencevillensis*, which occurs at the same horizon, in having the eyes much farther forward and larger, as well as in the shorter and wider shields. It differs from other known species of the genus in the same particulars.

Horizon and Locality:— The holotype, a gift of Mr. A. H. Becker and Mr. John H. Bradley, Jr., (M. C. Z. 1,583), was found near the top of the Maquoketa at Patterson's Spring, near Brainerd, Iowa.

Vogdesia Raymond.

Although proposed as a subgenus of Nileus, Vogdesia proves to be one of the Asaphinae, and closely related to Homotelus and Brachyaspis. This conclusion has been reached from a study of the dorsal surface, as the hypostoma has not yet been seen. Vogdesia differs from both the genera mentioned in having a wider axial lobe in the thorax, and little or no trace of dorsal furrows on the pygidium. The type is *Vogdesia bearsi* Raymond, from the Chazy. Other species are *Vogdesia minnesotensis* (Foerste) and Nileus sp. (Foerste, Bull. Denison univ., 1920, **19**, p. 218, pl. 23, fig. 4A, B), both from the Trenton, and *Vogdesia vigilans* (Meek and Worthen), a common trilobite in the Maquoketa.

Vogdesia gigas Raymond.

Plate **6**, fig. 8.

Vogdesia gigas Raymond, Bull. M. C. Z., 1920, **64**, p. 292.

This species differs from *V. vigilans* only in that the type is twice as large as the largest known specimen of the latter, the eyes are farther from the anterior margin, and the test is slightly if at all punctate.

Measurements:— Specimen, if extended, about 120 mm. long. The cephalon is 34 mm. long, and 58 mm. wide; an eye is 8 mm. long, and 8 mm. from the posterior margin. The pygidium is 36 mm. long, and 55 mm. wide, with no trace of an axial lobe. The thorax is estimated to be about 50 mm. long, each of the eight segments being 7 mm. long in the enrolled state.

Horizon and Locality:— This species is known from a single specimen collected by the writer near the base of the Maquoketa on a creek four miles west of Clermont, Iowa. Holotype (M. C. Z. 1,589).

Vogdesia vigilans (Meek and Worthen).

Asaphus (Isotelus) vigilans Meek and Worthen, Proc. Acad. nat. sci. Phil., 1870, p. 53. Geol. surv. Ill., 1875, **6**, p. 497, pl. 23, fig. 6.

Nileus vigilans Finch, Proc. Iowa acad. sci., 1904, **11**, p. 179, pl. 14. Slocom, Bull. Field mus. nat, hist. Geol. ser., 1913, **4**, no. 3, p. 52, pl. 14, fig. 9–15. Ann. rept. Geol. surv. Iowa, 1916, **25**, p. 199, pl. 15, fig. 9–15.
Vogdesia vigilans Raymond, Ann. Carnegie mus., 1910, **7**, p. 70.
Not *Nileus vigilans* of Clarke, Schuchert, and Grabau and Shimer.

This species is too well known to need any comment, and I am listing it here to emphasize the generic reference and to correct the bibliography.

Slocom says, "Free cheeks finely punctate." The same is true of the remainder of the body.

Horizon and Locality: — The original specimens were from the upper Ordovician shales of Carroll and Kendall Counties, Ill. It is very common in the lower Maquoketa near Elgin and Clermont, Iowa. It is also reported by Slocom from the same horizon at Bloomfield and from the upper Maquoketa at Patterson's Springs near Brainerd, Iowa.

Vogdesia minnesotensis (Foerste).

Illaenus (*Nileus*) *minnesotensis* Foerste, 15th rept. Geol. nat. hist. surv. Minn., 1886, p. 478, fig. 1.
Nileus vigilans Clarke, Geol. Minn., 1897, **3**, pt. 2, p. 712, fig. 17–19. Schuchert, Proc. U. S. N. M., 1900, **22**, p. 173. Grabau and Shimer, N. A. index foss., 1910, **2**, p. 299, fig. 1610 c, d. Slocom, Bull. Field mus. nat. hist. Geol. ser., 1913, **4**, no. 3, p. 53. Ann. rept. Geol. surv. Iowa, 1916, **25**, p. 200.

Slocom has pointed out that the specimens of *Nileus vigilans* found in the Trenton differ from the typical specimens in having the facial sutures marginal in front of the cranidium and in having the anterior part of the cephalon much less inflated. To this should be added the fact that the eyes are much less elevated and the palpebral lobes much larger, so that they cover a greater portion of the top of the eyes.

The lower eyes and depressed cranidium give this form quite a different appearance from the true *V. vigilans*, and since it has already received a name, it may as well be recognized as a distinct species.

Horizon and Locality: — This species is reported by Clarke from the Lower Trenton at Minneapolis and the "Galena" at Wykoff and Pleasant Grove, Minn. Foerste's original specimen was from Minneapolis. Specimens collected by the writer at Owatonna, Minn., are in the Carnegie Museum. Schuchert reported it from the Trenton of Baffin Land.

Nileoides Raymond.

Nileoides Raymond, Bull. M. C. Z., 1920, **64**, p. 284.

Some years ago I described a Chazyan trilobite under the name *Nileus perkinsi*. Although similar to Nileus, this species differs from all others of that genus in having the eyes relatively small and particularly in having them very far back. Another peculiarity is the strong development of the vertical suture on the doublure. I have examined with care great numbers of specimens of Nileus from Norway and Sweden without ever finding this suture, nor does it show in any of the American specimens. The strong development on *Nileoides perkinsi* is therefore of considerable importance.

Cephalon Nileus-like, glabella not outlined, cranidium smooth, gently convex, elongate, not abruptly inflected in front of the eyes. Eyes large, but not so large in proportion to the length of the cephalon as in Nileus. Vertical suture present. Axial lobe of thorax wide.

Type: — *Nileus perkinsi* Raymond. Upper Chazy, Vermont, and New York.

Nileoides perkinsi Raymond.

Nileus perkinsi Raymond, Ann. Carnegie mus., 1910, **7**, p. 69, pl. 18, fig. 7, 8. 7th rept. Vermont state geol., 1910, p. 224, pl. 38, fig. 7, 8. Proc. and trans. Roy. soc. Canada, 1912, ser. 3, **5**, sect. 4, p. 119, pl. 2, fig. 8, pl. 3, fig. 1.
Nileoides perkinsi Raymond, Bull. M. C. Z., 1920, **64**, p. 284.

This rare species has previously been known from only two specimens, one a cephalon, the other a cephalon and five segments of the thorax. Both were found on Isle La Motte, Vt. In 1919 I obtained a specimen in the reef at the base of the Upper Chazy, east of Chazy, N.Y., which retains the cephalon, thorax, and the anterior part of the pygidium. The vertical suture of the doublure is well shown, thus confirming the evidence of the other specimens.

The thorax contains eight segments, which are wide, flat, smooth, and lack dorsal furrows. There is not enough of the pygidium preserved to give any idea of its characteristics.

Isotelus iowensis Owen.

Asaphus (*Isotelus*) *iowensis* Owen, Rept. Geol. surv. Wisc., Iowa, Minn., 1852, p. 577, pl. 2, fig. 3–7, pl. 2, fig. 1–8.
Isotelus iowensis Clarke, Geol. Minn., 1897, **3**, pt. 2, p. 704. Slocom, Bull. Field mus. nat. hist. Geol. ser., 1913, **4**, no. 3, p. 48, pl. 13, fig. 1, 2. Raymond, Bull. M. C. Z., 1914, **58**, p. 255, pl. 2, fig. 6 (*non* pl. 3, fig. 1, 2). Slocom, Ann. rept. Geol. surv. Iowa, 1916, **25**, p. 193, pl. 14, fig. 1, 2.

Isotelus maximus Clarke (*partim*), Geol. Minn., 1897, **3**, pt. 2, p. 703, fig. 5.
Isotelus gigas Weller, Geol. surv. New Jersey Pal., 1903, **3**, pl. 14, fig. 5.

After making a considerable collection of Isotelus in the vicinity of Clermont and Elgin, Iowa, I conclude that there are two species there which have been passing under the name *Isotelus iowensis*. One form has a very punctate surface and the pygidium shows only faint traces of ribs. The other has very few puncta in the test, and the ribs are rather conspicuous on the surface, especially two or three at the anterior end of the pygidium. The second form also has a more elongate, less rounded pygidium than the first. Mature specimens are distinguished without difficulty, but exfoliated examples of the young are too much alike to be differentiated.

That the smoother of these forms is the original *I. iowensis* is shown by reference to Owen's original description and his metal-ruled figures on his plate 2 A. The restored view of plate 2, figure 3, is so obviously incorrect in many particulars that it cannot be taken as an illustration of the species.

Slocom has recently given a full description of this species, so that I shall refer only to a couple of details. Both Owen and Slocom state that the anterior margin of the cranidium makes a smooth curve, and that the sutures do not meet at an angle. This observation must have been based on poorly exposed material, for good specimens of free cheeks, cranidia, and entire cephala show that the sutures do meet at an angle, and that the free cheeks, though narrow, do extend to the middle of the front of the cephalon.

Horizon and Locality: — This species is very common in the Maquoketa shales at Elgin and in the vicinity of Clermont, Iowa, and Clarke figured a specimen from the same formation at Granger, Minn.

Isotelus walcotti Walcott.

Isotelus walcotti Walcott (Ulrich Mss.), Smith. misc. coll., 1918, **67**, p. 190, pl. 24, fig. 1.
Isotelus iowensis Raymond (*partim*), Bull. M. C. Z., 1914, **58**, p. 255, pl. 3, fig. 1, 2 (*non* pl. 2, fig. 6).

In discussing the specimens from the Trenton at Trenton Falls, N. Y., which in 1914 I referred to *Isotelus iowensis*, I stated that "The specimens from the Trenton, though sometimes larger, are too much like the Iowa specimens to be distinguished as a distinct species at the present time."

Walcott has recently figured, without description, one of these specimens from Trenton Falls, and given to it a manuscript name suggested by Dr. Ulrich. After restudying the material from the Trenton in connection with a much larger collection from the Maquoketa than was available to me five years ago, I am able to find some minor differences which may justify the new species, especially since the specimens are found in such widely separated localities and at different horizons. The chief difference lies in the fact that although the glabellae of the two forms are alike in shape and furrows, the anterior portion is much more definitely outlined in *I. walcotti* than in *I. iowensis*, and there is also a median carina along the middle of the glabella in the former species, as shown in Dr. Walcott's figure.

The change in name does not alter the force of my remarks in the paper of 1914. *Isotelus walcotti* was apparently derived from *I. gigas* through the inhibition of complete development and grew to adult size while retaining many of the juvenile characteristics. *Isotelus iowensis* is a very slightly modified descendant which survived to the late Ordovician. This furnishes a very good example of the formation of a new species by a sudden "jump," due in this case to the failure of complete development (bradygenesis).

Horizon and Locality: — All of the completely identified specimens of *Isotelus walcotti* have been found in the "Walcott quarry," east of the gorge at Trenton Falls, N. Y. There are eight complete specimens and a number of fragmentary ones in the M. C. Z.

Isotelus rejuvenis Raymond.

Plate 5, fig. 6.

Isotelus rejuvenis Raymond, Bull. M. C. Z., 1920, **64**, p. 294.

Entire specimen elongate oval, narrow, strongly convex. Cephalon large, with short genal spines which in uncrushed specimens have their outer surfaces nearly vertical. The facial sutures follow the same course as in *I. iowensis*, being very close to, and parallel to the anterior margin. The eyes are very small, elevated, situated a trifle more than their own length in front of the posterior margin. The glabella is faintly outlined, constricted between the eyes, and nearly smooth.

Thorax as in *I. iowensis*, the dorsal furrows shallow, and the axial lobe more than one third and less than one half the total width.

Pygidium elongate, narrow, with steep sides. The axial lobe is narrow, faintly outlined except in young specimens, and without rings

except for the one on the anterior end. The pleural lobes show traces of several pairs of ribs, two of which at the anterior end are very distinct.

Measurements: — The holotype is 105 mm. long; the cephalon is 38 mm. long, and 62 mm. wide; the pygidium is 46 mm. long, and 55 mm. wide.

This species differs from *Isotelus iowensis* in having smaller eyes, a longer and narrower pygidium with two pairs of ribs on the anterior end, and in having a less densely punctate shell.

In the following table, measurements (in mm.) of specimens of *Isotelus rejuvenis, I. owensis,* and *I. walcotti* are given in parallel columns for comparison. It will be noted that although the proportions of specimens of *I. walcotti* and *I. iowensis* are about the same, *I. rejuvenis* is somewhat narrower, and has a longer pygidium.

	Isotelus rejuvenis		*Isotelus iowensis*			*Isotelus walcotti*	
Total length	105		52			54	
Greatest width	62		30			31	
Index — Width ÷ length	.59		.57			.57	
Length cephalon	38		19			19	
Index — Length ÷ width	.61		.63			.61	
Length pygidium	46	37	19	60	40	20	49
Width pygidium	55	42	25	77	54	26	64
Index — Length ÷ width	.87	.88	.76	.78	.74	.77	.76

Horizon and Locality: — The species has so far been found only in the lower part of the Maquoketa at Clermont and Elgin, Iowa, at both of which places it is rather common in association with *I. iowensis.* The holotype (M. C. Z. 1,586) was collected by the writer on a creek about four miles west of Clermont.

Ectenaspis Raymond.

Ectenaspis Raymond, Bull. M. C. Z., 1920, **64**, p. 292.

Several years ago Mr. A. G. Becker, while collecting in the ravine of a small stream about two miles west of Clermont, Iowa, came upon a slab of limestone on which were two specimens of the trilobite which Slocom later described as *Megalaspis beckeri* (Bull. Field mus. nat. hist. Geol. ser., 1913, **4**, p. 50, pl. 14, fig. 5. See also Geol. surv. Iowa, 1916, **25**, p. 196, pl. 15, fig. 5). The outstanding feature of this animal is the great elongation of the anterior portion of the cephalon. The elongate triangular head-shield invited a comparison with such asaphids as *Megalaspis extenuata* (Dalman), hence the generic reference.

No one has as yet been fortunate enough to discover an hypostoma of this species, so that it is not possible to say definitely that *M. beckeri* is not a Megalaspis, but that it is almost certainly not one is indicated by the following considerations: —

1st. Nearly all the species of Megalaspis in the typical region in northern Europe are found in the Lower Ordovician, only one or two surviving till the Middle Ordovician, and none till the Upper Ordovician rocks were deposited.

2d. Megalaspis is exceedingly rare in America, whereas isotelids are common and highly variable.

3d. No hypostoma of the ogygiocarinid type has been found in the Maquoketa.

4th. The glabella of *Megalaspis beckeri* is not definitely outlined and is long, whereas in all species of the true Megalaspis the glabella is outlined and is relatively short.

5th. The axial lobe of the thorax of *M. beckeri* is wider in proportion to the total width than is that of any species of the true Megalaspis.

In consideration of the above, I made *Megalaspis beckeri* the type of a new genus, Ectenaspis, the extended or stretched out character of the cephalic shield suggesting the name. This genus seems very close to Isotelus, and its derivation from Isoteloides through some such forms as *I. angusticaudus* Raymond and *Ectenaspis homalonotoides* (Walcott) is quite probable.

Ectenaspis beckeri (Plate **9**, fig. 7) is an exceedingly rare fossil in the lower part of the Maquoketa (Upper Ordovician) in Fayette Co., Iowa. The only other species which can now be placed in this genus is *Ectenaspis homalonotoides* (Walcott).

Ectenaspis homalonotoides (Walcott).

Plate **4**, fig. 9, 10.

Asaphus homalonotoides Walcott, 31st rept. N. Y. state mus. nat. hist., 1879, p. 70 (advance sheets, 1877, p. 70). Whitfield, Geol. Wisc., 1882, **4**, p. 237, pl. 5, fig. 4.

Asaphus triangulatus Whitfield, Ann. rept. Wisc. geol. surv., 1879 (1880), p. 59.

Isoteloides homalonotoides Raymond, Bull. 1, Victoria mem. mus., 1913, pl. 4, fig. 5.

Not *Isoteloides homalonotoides* Raymond and Narraway, Ann. Carnegie mus., 1910, **7**, p. 52, pl. 16, fig. 9–11.

Lack of figures has caused some confusion about this species, both to Whitfield and myself. The types are in the Walker Museum at the University of Chicago, and Mr. A. W. Slocom was good enough to send me excellent casts from which I have had illustrations prepared. The anterior end of the cranidium is drawn out into a sharp point in the same manner though not to so great an extent as that of *Ectenaspis beckeri*, and the pygidia of the two species are practically identical. It seems therefore that *Asaphus homalonotoides* must be referred to Ectenaspis rather than to Isoteloides.

The cranidium is long and narrow, pointed in front, depressed convex. The glabella is definitely, though faintly, outlined, about three fourths the total length, has nearly parallel sides, being contracted but slightly between the eyes, and shows faintly two pairs of glabellar furrows. The eyes and palpebral lobes are entirely broken away, but a fold in the test just in front of them indicates that they were elevated, possibly high, as in *E. beckeri*. They are situated far back and the fixed cheeks are very narrow. The neck-furrow is shallow on the axial lobe, somewhat more distinct on the fixed cheeks. In front of the glabella is a wide depressed border.

The pygidium is triangular, pointed behind, with a narrow concave border. The axial lobe is prominent, narrow, eight tenths the entire length. There are traces of about six rings on the axial lobe, and three or four pairs of ribs show faintly on the sides.

Measurements:— The cranidium is 16.5 mm. long, 11 mm. wide in front of the eyes; and the glabella is 12 mm. long. The pygidium is 18.5 mm. long, 23 mm. wide at the front; the axial lobe is 15 mm. long, 8 mm. wide at the front, and 3 mm. wide 2 mm. in front of the posterior end.

The only known specimen showing the thorax is that in the Victoria

Memorial Museum at Ottawa. It retains seven segments attached to the pygidium, and shows that the axial lobe occupies about the same proportion of the total width as in *E. beckeri*.

Horizon and Locality:— The types were found at Dunlith, Ill., at a horizon said to be near the base of the Trenton. The specimen in Ottawa was found by Mr. W. A. Johnston in the crinoid beds along the Trent Canal near Kirkfield, Ont., at a horizon less than eighty feet above the base of the Trenton.

Hyboaspis Raymond.

Hyboaspis Raymond, Bull. M. C. Z., 1920, **64**, p. 385.

This name was proposed for a curious trilobite in the pygidium of which are combined the elongate form of the asaphid and the short axial lobe of the illaenid. I know of no asaphid with short axial lobe on the pygidium and only in Actinolobus among the Illaenidae is there any hint of elongation of the pygidium and even there nothing comparable to what is seen in the form described. Although the ascription of the genus to either the Asaphidae or Illaenidae cannot positively be made until the cephalon is found, I have for the present placed it with the Asaphidae. Type: —*Hyboaspis shuleri* Raymond.

Hyboaspis shuleri Raymond.

Plate **5**, fig. 3, 4, 8.

Hyboaspis shuleri Raymond, Bull. M. C. Z., 1920, **64**, p. 285.

Cephalon and thorax unknown.

Pygidium elongate, narrow, highly convex, turned up somewhat at the posterior end. Axial lobe low, not sharply outlined, without rings, a trifle more than one third the total length. Pleural lobes steep-sided, with narrow concave border, which does not extend around the posterior end. No traces of ribs, except for the anterior one. Surface of pleural and axial lobes crossed by wavy cracks which have a course approximately at right angles to the axis. Doublure wide, especially at the posterior, where it extends half way to the front, and marked by deep but widely separated terrace lines.

Measurements:— The largest pygidium is 73 mm. long, and about 56 mm. wide. The smallest is 22 mm. long, and 21 mm. wide. In the large specimen the axial lobe is 25 mm. long. In the small one it is 8 mm. in length.

Horizon and Locality:— Only three pygidia of this species have

so far been found: two by Dr. E. W. Shuler in 1914 and one by the writer in 1917. All came from the middle of the Holston in the McNutt quarry at Sharon Springs, Bland Co., Va. Cotypes (M. C. Z. 1,587, 1,588).

Hyboaspis depressa, sp. nov.

Plate 5, fig. 1, 2.

Among the trilobites collected from the Chazy in 1919 is a considerable number of pygidia which resemble those of *Isotelus platymarginatus* Raymond but which have the short axial lobe of Hyboaspis. They differ from *H. shuleri* in having a subcircular outline and depressed form.

Unfortunately no entire specimens were found, and there is nothing to indicate whether any of the detached cephala in the collection may belong with them. *Isotelus harrisi*, *I. platymarginatus*, *Nileoides perkinsi*, and other more or less large smooth specimens were found in the same strata. Since the pygidium of *Nileoides perkinsi* is unknown, it might be suspected that these shields belong to that species, were they not all much too large.

Cephalon and thorax unknown. The pygidium has roughly the outline of a truncated circle, the greatest width being behind the anterior margin. Surface of the central portion evenly convex, sloping gently into a wide concave border. Axial lobe not much elevated, wide at the front, short, tapering rapidly. Dorsal furrows shallow. Half way down the slope there is another furrow, variously developed on different specimens, but usually rather faint, especially behind the axial lobe. It is approximately parallel to the margin. The surface of the shell is covered with very narrow cracks which are somewhat wavy, but in general transverse to the axis.

Measurements:— A small pygidium is 35 mm. long, about 42 mm. wide at the anterior end; the axial lobe is 14 mm. long, and 16 mm. wide at the front. A larger one is 56 mm. long, about 66 mm. wide; and the axial lobe is 20 mm. long.

Horizon and Locality:— This species is fairly common in the reef at the base of the Upper Chazy, two miles southeast of Chazy, N. Y., where ten pygidia (including the cotypes M. C. Z. 1,683, 1,684) were collected by the writer. A specimen from the same horizon on Isle La Motte, Vt., collected by Professor Hyatt, has long been in the M. C. Z., and another one, probably from the same horizon, was found in Prof. H. M. Seeley's collection at Middlebury College.

Illaenidae Corda.

Illaenus fraternus Billings.

Illaenus fraternus Billings, Pal. foss. Canada, 1865, **1**, p. 276, fig. 262a, b.

This species is readily recognized by the subhemispheric form of the cranidium, the straight dorsal furrows, and the nearly smooth surface. The profile is much more nearly a semicircle than that of any other of the species from Newfoundland. The surface of the cranidium is covered with fine cracks but they are finer, farther apart, and less continuous than those of *I. consimilis* and much less conspicuous.

The axial lobe of the pygidium is low, and the dorsal furrows faint.

Horizon and Locality: — Billings listed this species from division L, Point Rich, N, Table Head, and the conglomerates of P, four miles northeast of Portland Creek, Nfld, but Professors Schuchert and Twenhofel found it only in their zones 10 and 11 at Point Rich. I have not seen it elsewhere.

Illaenus consimilis Billings.

Illaenus consimilis Billings, Pal. foss. Canada, 1865, **1**, p. 277, 331, fig. 263a–c, 317, 318a.

This species was fully described by Billings, and the present collection has brought out no new information. It is one of the common fossils at its horizon and the cranidia are very readily recognized, since they are covered with coarse elevated striae and cracks roughly parallel to the anterior margin. The top of the cranidium appears somewhat concave, since the palpebral lobes are at an elevation higher than the glabella. As shown in Billings's figure, the free cheeks have broadly rounded genal angles and show a curious indentation in the margin below the eye. The eyes are situated so far back as practically to reach the posterior border.

The pygidium shows wrinkles similar to those on the cranidium, but they are less crowded and are found principally on the anterior and lateral portions, the region back of the low axial lobe being smooth.

Horizon and Locality: — Billings recorded this species from division L, Point Rich, and M and N, Table Head, Newfoundland. Professors Twenhofel and Schuchert collected it in their zones M_2, N_1, and N_2, and in the Isolated limestone, all at Table Head, Nfld. I have not seen the species elsewhere.

Illaenus valvulus, sp. nov.

Plate 4, fig. 13, 14.

Cranidium short, high, and very smooth. The dorsal furrows are very short and show as indistinct depressions near the posterior margins, rather than regular furrows. The frontal slope is steep, evenly convex, and on the top the glabella is elevated slightly above the cheeks. The palpebral lobes are large and close to the posterior margin. The shell is smooth and polished, but where the surface is exfoliated there seems to be an inner shell with minute and rather sparsely scattered puncta.

Only one segment of the thorax, the posterior one, has been seen. From it one would judge that the segments were very short, flat, and that the axial lobe was wide.

The pygidium is almost flat, very smooth, and the axial lobe is indicated only at the anterior border. The surface shows a few very fine wrinkles and puncta.

Measurements: — A cranidium is 5 mm. long in projection and 11 mm. over the curve. It is 13.5 mm. wide at the palpebral lobes. The last segment of a thorax is 7.5 mm. wide. A pygidium is 6 mm. long, and 16 mm. wide.

Horizon and Locality: — A rare species, found only in the Holston in the Catawba Valley, north of Salem, Va. Cotypes (M. C. Z. 1,651, 1,652).

Illaenus lautus, sp. nov.

Plate 4, fig. 11, 12.

Cranidium short, high, with a very steep frontal slope. The dorsal furrows are narrow but distinct and converge throughout the greater part of their courses, turning outward at the anterior ends. The glabella is on the same level with the cheeks and exfoliated specimens show a very faint median ridge which extends to the anterior margin. Close to the posterior margin, on what would be the neck-ring were there a nuchal furrow, is a small median pustule. The eyes are of medium size, situated close to the posterior margin. The test, so far as it is preserved, appears to be smooth.

Measurements: — A cranidium is 7 mm. long (in projection) and 15 mm. measured over the curve. It is 16 mm. wide at the palpebral lobes. All of the specimens are small.

Horizon and Locality: — This is a rather rare species found so far

only in the Holston at the Ross Republic quarry, three miles southeast of Knoxville, Tenn., and in the Holston in the Catawba Valley, north of Salem, Va. The cotypes (M. C. Z. 1,653, 1,654) are from the former locality.

Illaenus fieldi, sp. nov.

Plate 7, fig. 1–4.

A large Illaenus with subhemispheric cephalon, deep dorsal furrows, and small eyes. The furrows are strongly marked, wide and deep. In their course they first converge for a short distance then become roughly parallel, and near the top of the anterior slope, turn rather sharply outward. The median lobe of a single exfoliated specimen from the Holston in the Catawba Valley, Va., shows four pairs of scars, corresponding to glabellar furrows. The eyes are small, situated very close to the posterior margin, and the palpebral lobes are depressed below the surface of the glabella and fixed cheeks. The surface of the shell shows numerous shallow puncta, and around the anterior margin there is a slightly elevated striated rim.

No thorax which can with absolute certainty be assigned to this species is known.

The pygidium is of a very common type, depressed convex, with short, wide, low axial lobe, and the sides sharply truncated so that they make an angle of about 115° with the anterior margin. The surface is covered with closely packed, fine wrinkle-like raised lines.

Measurements: — A cranidium is 20 mm. long in projection, and about 36 mm. wide at the palpebral lobes. The length measured over the curve is 35 mm. Another cranidium is 21 mm. long in projection 36 mm. over the curve; and 37 mm. wide at the palpebral lobes. A small pygidium is 8 mm. long, 13 mm. wide at the front, and 14.5 mm. wide at the back. A larger one is 17 mm. long, about 25 mm. wide at the front, and about 27 mm. wide at the back.

This species is most nearly allied to *Illaenus americanus*, differing from that species chiefly in the greater curvature of the dorsal furrows. The dorsal furrows of *I. americanus* bow slightly outward in the middle of their course, whereas those of *I. fieldi* bow inward. The similarity in convexity of head, shape and position of eyes, and of pygidium in the two species is rather remarkable. In shape of cranidium and course of glabellar furrows, *Illaenus marginalis* approaches *I. fieldi*, but the eyes of the latter species are very much smaller than those of the former.

Horizon and Locality:— This is the most common Illaenus in the Lower Middle Ordovician of Virginia and Tennessee. The cotypes (M. C. Z. 1,658–1,660) are from the Holston in the Catawba Valley, north of Salem, Va. It is also common in the Holston at the Hoge farm, Bland Co., Va., and occurs in the same formation at the McNutt quarry near Sharon Springs, Bland Co., near Ceres, Bland Co., Va., and at Concord, Tenn. It is very common at the base of the Liberty Hall at Lexington, Va., and fairly common in the Ottosee at Speers Ferry and north of Mendota, Va. A number of specimens were collected from the Lenoir, southeast of Knoxville, Tenn., and one from the Pearisburg at Pearisburg, Va. Specimens of pygidia believed to belong to this species were found in the shale at the base of the Ottosee at Luttrell, Tenn., and a thorax and pygidium near the base of the Holston at Lone Mountain, Tenn. Some poorly preserved specimens, not positively identified, come from the Ottosee near Goodwins Ferry on the New River, Va. Specimens have been collected by Profs. S. L. Powell, R. M. Field, E. W. Shuler, and the writer.

Illaenus bayfieldi Billings.

Illaenus bayfieldi Billings, Canad. nat. geol., 1859, **4**, p. 369, fig. 4–6. Geol. Canada, 1863, p. 133, fig. 65a–c. Raymond, Ann. Carnegie mus., 1905, **3**, p. 348, pl. 13, fig. 11, 12. 7th rept. Vermont state geol., 1910, pl. 35, fig. 11, 12.

Billings mentioned this species as the only Illaenus known to him, entire specimens of which were common. Sir William Logan must have been unusually fortunate in his visit to the Mingans in 1859 as subsequent collectors have not found the species particularly abundant, and it has not been found outside those islands. Professor Twenhofel collected a very excellent enrolled specimen from Harbor Island, and two cranidia on the west of Quarry Cove (Quarry Island). It is listed from zone A_3 of Schuchert and Twenhofel's section only.

The principal characteristics of this species are the short, wide, evenly convex head, short, straight, rapidly converging dorsal furrows and small eyes, situated very far apart and close to the posterior margin.

Measurements:— The following measurements were taken from the specimen collected by Professor Twenhofel. Length of cephalon (in projection) 14 mm., along the curve 24 mm. Width at genal angles 34 mm.; at palpebral lobes 28 mm.

Illaenus marginalis, sp. nov.

Plate 7, fig. 8, 9.

A large Illaenus with a high, evenly convex cranidium which is rather flat on top. The dorsal furrows are wide and shallow, far apart at the posterior margin. Their courses converge to a point opposite the anterior margins of the eyes, and there turn outward and fade out. The top of the glabella is about even with the palpebral lobes. These latter are large, and situated about one half their own length from the posterior margin. Around the anterior margin is a raised, striated, convex border. No well-preserved free cheek has been seen, in spite of the fact that this is a common species.

The associated pygidium is depressed convex, with wide, faintly outlined axial lobe.

Measurements:— Length of cranidium (in projection) 22 mm. over the curve 47 mm.; width at palpebral lobes 44 mm., length of a palpebral lobe 7 mm. Length of a pygidium 18 mm., width 34 mm.; width of axial lobe at front 13 mm.

Horizon and Locality:— Numerous cranidia and pygidia of this species were collected by Professors Schuchert and Twenhofel in their zones 10 and 11 at Point Rich, a few specimens in their zone M_1 at Table Head, and numerous small ones in the Isolated limestone at Table Head, Nfld. Professor Hyatt obtained some rather poor fragments of the same species at Port au Port, Nfld. Types in the Yale University Museum.

Illaenus alveatus, sp. nov.

Plate 7, fig. 5.

This species is remarkable because it has a narrow concave brim on the front of the cranidium. The cranidium is short, high and wide, the front very steep, almost vertical. The dorsal furrows are short, shallow, and narrow, and after first converging slightly for a short distance, turn outward and become lost at the top of the anterior slope. The glabella is scarcely raised above the general surface and of course merges into the general even convexity of the front. The palpebral lobes show that the eyes were large, close to the posterior margin, and distant from the dorsal furrows. The anterior brim is narrow, being merely a narrow trough with upturned rim. The specimens are largely exfoliated, but such patches of test as are retained show no surface markings.

On the same small fragment of limestone with one of the cranidia is a fragment of a thorax showing the greater part of six segments and a partially exfoliated pygidium. They are of the right size to have belonged to this cranidium and it is presumed that they are part of the same specimen. The axial lobe of this thorax is rather wide for an Illaenus, and only slightly convex. The pleural lobes are flat near the dorsal furrows, and then abruptly deflected to form steeply sloping sides. The pygidium is short and wide with a short, low axial lobe which is rather sharply outlined. The surface of the test shows a few small irregularly scattered puncta.

Measurements:— One cranidium is 8 mm. long (in projection), and 19 mm. wide at the axial lobes. The six segments of thorax associated with this cranidium are 6 mm. long, the width 20 mm. at the front, and the axial lobe 8 mm. wide. The pygidium is 7.5 mm. long, and 15 mm. wide. The axial lobe is 6 mm. wide at the front.

The very low glabella, lightly impressed glabellar furrows, and the presence of an anterior brim separate this species from other described species. The latter characteristic in fact, makes this species unique among the Illaeninae, and to be strictly logical, the species should perhaps be transferred to the Bumastinae, where, however, it could not be assigned to any established genus.

A closely allied species is *Illaenus weaveri* Reed (Quart. journ. Geol. soc. London, 1909, **65**, p. 142, pl. 6, fig. 1a–1c, 2, 3) from the Llandeilo of Counties Mayo and Galway, Ireland. It has the same shape, and particularly the same very abrupt deflection of the front of the cephalon, but lacks the curious lip-like brim.

Horizon and Locality:— This is a very rare species, collected by Professors Schuchert and Twenhofel in their zone 10 between Gargamella Cove and Point Saunders, Nfld., and in zone 11 at Point Rich, Nfld. Holotype in the Yale University Museum.

Illaenus protuberans, sp. nov.

Plate **8**, fig. 1, 2.

Although but a single cranidium of this species has been found, it differs so greatly from any other known species of the true Illaenus that it is quite within the bounds of propriety to describe it. The cranidium is small, high, protuberant in front. Viewed from above, the outline is triangular, the median lobe elevated above the cheeks and having very much the same form as the same lobe in *Amphilichas*

prominulus (p. 126). The palpebral lobes are very indistinctly shown by the specimen but appear to be small and close to the posterior border. The surface seems to be smooth, except for terrace lines along the anterior border.

Measurements: — Length of cranidium 9 mm., width at palpebral lobes, about 11 mm.; width of axial lobe at posterior margin 5.75 mm.

The only species with which this one can be compared is *Illaenus conifrons* Billings, which is found in the Upper Chazy of the Mingan Islands. That species, however, has the long, elevated eyes of a Thaleops, whereas the specimen from Virginia is surely an Illaenus. Except for the eyes and size, the species are much alike.

Horizon and Locality: — The single specimen (Holotype M. C. Z. 1,661) was collected from the granular limestone at the top of the Holston at the Thomas farm, three miles northeast of Blacksburg, Va.

Illaenus tumidifrons Billings.

Illaenus tumidifrons Billings, Pal. foss. Canada, 1865, **1**, p. 278, fig. 264a, b.

This species was very fully described by Billings, and is easily recognized by its very tumid cephalon. The eyes are a little larger and a little farther back than in Billings's 264a. Even small specimens have ten segments in the thorax, an extended specimen 5 mm. long having the full number.

Horizon and Locality: — Billings's original specimens were from the conglomerates of Division Pat Cow Head, Nfld. Professors Schuchert and Dunbar obtained numerous cranidia and pygidia and two entire specimens from the same locality. It has never been reported elsewhere.

Illaenus consobrinus Billings.

Illaenus consobrinus Billings, Pal. foss. Canada, 1865, **1**, p. 280, fig. 266a, b.

Professors Schuchert and Dunbar obtained ten cranidia of this species from the type-locality at Cow Head, Nfld., where it occurs in pebbles in the Cow Head conglomerate.

Illaenus viator, sp. nov.

Plate **6**, fig. 16, 17.

A large Illaenus, represented by four nearly complete specimens, three of which are natural moulds, and one partially enrolled retaining a part of the test.

All are somewhat flattened, so that the natural curvature cannot be determined. The cephalon is very wide, for even with the free cheeks lacking, the palpebral lobes extend beyond the margin of the thorax. The dorsal furrows are deep at the posterior margin, grow fainter as they converge forward. The glabella is ovate, depressed convex, very wide at the back.

The thorax has ten segments and a very wide axial lobe.

The pygidium bears a short, wide axial lobe which is only partly encircled by the dorsal furrows. The pleural lobes have straight sides which make an angle of about 105° with the front.

The enrolled specimen is unique in that it is the only American illaenid I have ever seen which retains the hypostoma. This organ is not exactly in place, but is still present on the median line of the glabella. It presents no unusual characteristics, but is very small, only about one third the apparent length of the cephalon.

This species seems to be most like *Illaenus latiaxiatus* Raymond and Narraway. The two agree in the very wide axial lobe, convergent glabellar furrows, and the angle of truncation of the sides of the pygidium. *I. viator* seems to have the eyes farther apart and a shorter and wider cephalon. *Illaenus americanus* Billings is another closely allied species, but has a narrower axial lobe, differently curved dorsal furrows, and the truncated sides of the pygidium diverge at a wider angle.

Measurements: — The specimens are all so poorly preserved that only approximate measurements can be secured. The best specimen is 48 mm. long, 43 mm. wide at the palpebral lobes; the cephalon is 18 mm. long; the thorax 13 mm. long; the pygidium 17 mm. long, and 30 mm. wide. The cephalon of the enrolled specimen is about 25 mm. long (much flattened), and the hypostoma 7 mm. long, and 9 mm. wide.

Horizon and Locality: — The specimens are from a thinly bedded sandstone, determined by Professor Schuchert to be of late Richmond age, on the west shore of Long Point, Nfld. Professors Schuchert and Dunbar, collectors, 1917. Cotypes in the Yale University Museum.

Illaenus, sp. ind.

Two imperfect cranidia from the lower part of the Richmond, Newfoundland are of interest only from the fact that the genus is not elsewhere recorded from this horizon.

The better specimen, found on the shore opposite Black Duck Bay, can hardly be distinguished from a cranidium of *Illaenus americanus,*

except that the dorsal furrows converge somewhat more sharply in the first 2 mm. of their courses. The profile is also different, the front being much less incurved.

The other cranidium found near Long Point lighthouse is very badly preserved, but may possibly be a small specimen of *Illaenus viator*.

Thaleops clavifrons (Billings).

Illaenus clavifrons Billings, Canad. nat. geol., 1859, **4**, p. 379.
Illaenus vindex Billings, Pal. foss. Canada, 1865, **1**, p. 179, fig. 160. Raymond, Ann. Carnegie mus., 1905, **3**, p. 353, fig. 2.

This species was but briefly described by Billings, as he considered it as possibly only a variety of *Illaenus conifrons*. Later, however, he described more perfect specimens under another name. The two cannot occur together very regularly, for Professor Twenhofel collected a large number of *Thaleops clavifrons*, but did not bring back a single fragment of *I. conifrons*. Both species are probably to be referred to Thaleops, though the eyes of *I. conifrons* are not yet fully known.

Cranidium quadrate, dominated by the glabella which has a very steep frontal slope. The dorsal furrows are parallel from the posterior margin half way to the front, there turn abruptly outward and finally converge again around the front of the glabella, though very faint there. The top of the glabella is nearly flat, and on the constricted neck-portion are traces of two or sometimes three pairs of furrows. These show much more plainly on some specimens than on others and generally take the form of slight swellings. The cheeks are depressed below the surface of the glabella, but the long palpebral lobes raise the eyes above them. The surface of small specimens is covered with numerous coarse puncta. In large specimens these puncta become relatively large, somewhat irregular depressions which give the surface a unique appearance. Free cheeks and thorax unknown. Pygidium convex, truncated at the sides, with high axial lobe, and the same surface markings as the cranidium.

Measurements:— A small cranidium is 6 mm. long (in projection), and 11 mm. wide at the palpebral lobes. A cranidium of medium size is 10 mm. long (in projection) 17 mm. long over the curve; and 21 mm. wide at the palpebral lobes. The glabella is 5.5 mm. wide at the back, and 9 mm. wide at its widest point near the front. A large cranidium is 15 mm. long in projection, and about 34 mm. wide at the palpebral lobes. A large pygidium is 18 mm. long, 27 mm. wide at the front, and 30 mm. wide at the back.

The ornamentation is sufficient to distinguish this from any other described species of Thaleops.

Horizon and Locality:— This is a common species in zones A_3 and A_5 of the Mingan formation of Upper Chazy age in the Mingan Islands. Professor Twenhofel collected it on Large Island, Harbor Island, the west side of Quarry Cove, and Panoquet.

Bumastus erastusi Raymond.

Illaenus erastusi Raymond, Ann. Carnegie mus., 1905, **3**, p. 351, pl. 13, fig. 8, 9.
Bumastus erastusi Raymond, Ann. Carnegie mus., 1910, **7**, p. 71. 7th rept. Vermont state geol., 1910, p. 229, pl. 35, fig. 8, 9.
?Illaenus crassicauda Hall, Pal. N. Y., 1847, **1**, p. 24, pl. 4 bis, fig. 13.

This species was described originally from the strata at the base of the Upper Chazy on Valcour Island, N.Y. Professor Twenhofel found a considerable number of specimens on the Mingan Islands which are probably to be referred to it, though there are some differences. The dorsal furrows are shorter on the specimens from the Mingan Islands than on those from New York, and the pits ahead of the furrows, which are so prominent on the original specimen, are small and inconspicuous.

The pygidia from both localities agree in being elongate, highly convex, no axial lobe defined except by the depressions at the anterior margin, and in showing a faint concavity in the profile of the posterior slope.

One specimen collected by Professor Twenhofel has the cranidium and pygidium connected by a somewhat crushed thorax, so that the correctness of the association of the two shields is assured.

This species is associated both at Valcour Island and in the Mingan Islands with *Bumastus globosus*. It has a less highly elevated cranidium than that species, and a much longer pygidium.

Horizon and Locality:— This species has been found in the Middle and Upper Chazy, at the lower end of Lake Champlain in New York, and Vermont, and in zone A_5 (Upper Chazy) on Bald Island and Large Island, Mingan Islands.

Bumastus porrectus, sp. nov.

Plate **8**, fig. 7, 8.

Bumastus trentonensis Clarke (*non* Emmons), Geol. Minn., 1897, **3**, pt. 2, p. 720, fig. 32 (*non* fig. 30, 31, 33). Grabau and Shimer, N. A. index fossils, 1910, **2**, p. 298, fig. 1610b.

When Mr. Narraway and I wrote of the history and status of the names *Bumastus trentonensis* and *Illaenus trentonensis* we somewhat weakly intimated that there might be some trilobite of this family which could use the name *trentonensis*, but the more the question is studied the more certain it becomes that the only proper method is to suppress the name entirely. Such action leaves bumastids which are rather common at Trenton Falls and elsewhere without names, a condition which I shall endeavor to remedy forthwith.

The entire animal is about one half longer than wide, slender, with slight traces of dorsal furrows.

The cephalon is somewhat plumper than the quarter of a sphere, evenly convex, and vestiges of dorsal furrows are seen in very faintly visible traces of lunettes. The eyes are small, situated far back and far apart. The free cheeks are small and so nearly vertical in position that they are concealed by the eyes when viewed from above.

The thorax has ten segments, is evenly convex, and has a very wide axial lobe which is delimited by broad, shallow, dorsal furrows.

The pygidium is short, smooth, and evenly convex, without any trace of an axial lobe.

The surface of the entire test is smooth, the only ornamentation being faint concentric wrinkles on the anterior margins of both cephalon and pygidium.

Measurements:— Entire length of the type, about 23 mm. (cephalon slightly displaced). Width of cephalon 13 mm., length in projection 9 mm. over the curve 12 mm.; width at the palpebral lobes 12 mm. Length of thorax 6.5 mm., width at front 12.5 mm., width at back 11.5 mm.; width of axial lobe at front 9 mm. Length of pygidium 8.5 mm., width 11 mm.

This species differs from most other described bumastids in the almost total absence of dorsal furrows from the cephalon. Its nearest ally, *Bumastus milleri* (Billings), frequently has the lunettes equally obscure, but in that case the dorsal furrows usually appear as shallow depressions at the posterior margin. *Bumastus milleri* has a wider cephalon than *B. porrectus*, so that the entire animal is less slender, and has the appearance of tapering much more rapidly toward the pygidium. It would, however, be almost impossible to distinguish isolated cranidia and pygidia of the two species. *Bumastus milleri* always has nine thoracic segments. *B. porrectus* usually has ten, but may have only nine.

Horizon and Locality:— The type and the specimen figured by Dr. Clarke in the Paleontology of Minnesota are from the upper third of

the Trenton at Trenton Falls, N. Y. The type (M. C. Z. 728) was collected by Dr. C. D. Walcott.

Bumastus holei Foerste.

Plate 8, fig. 5, 6.

Bumastus holei Foerste, Bull. Denison univ., 1920, **19**, p. 214, pl. 21, fig. 15a, b; pl. 22, fig. a, b.

Entire animal obovate in outline, evenly convex, the cephalon considerably larger than the pygidium. The cephalon is evenly convex, with a slight longitudinal median depression. The dorsal furrows are represented by large depressed lunettes from which, on the cast, shallow furrows extend straight back to posterior margin, whereas on testiferous specimens only the lunettes show. The eyes are small, very far apart, close to the posterior margin. The free cheeks are small and so nearly vertical in position as to be hardly visible from above. There is a minute median pustule just in front of the narrow obscure nuchal furrow and the surfaces of exfoliated cranidia are covered with rather coarse puncta; where the shell is preserved, it is granulose.

The thorax has ten segments. The axial lobe is very wide and the dorsal furrows very shallow. The surface is granulose. The pygidium is about four fifths as long as wide, evenly convex, without trace of axial lobe. Exfoliated specimens show a median longitudinal furrow which becomes deeper posteriorly and at the anterior end faint traces of four or five segments, behind which are two large faintly raised areas, one situated on either side of the median groove. These latter markings probably indicate the position of the attachment of the dorsal (extensor) muscles. The exterior surface is faintly granulose and has a few delicate, raised lines parallel to the anterior margin. When exfoliated, the surface is punctate, like the cephalon.

Measurements: — The largest entire specimen in the collection is 54 mm. long, 32 mm. wide at the genal angles; and 27 mm. wide at the pygidium. The cephalon is 20 mm. long in projection and 31 mm. over the curve. The inner edges of the lunettes are 17.5 mm. apart and the width at the palpebral lobes is 29 mm.

The plesiotype is 37 mm. long, 24 mm. wide at the genal angles; 20 mm. wide at the pygidium. The cephalon is 13 mm. long in projection, 22 mm. wide at the palpebral lobes, and the lunettes are 12 mm. apart. The thorax is 13 mm. long, 23 mm. wide at the front, 20 mm.

wide at the back; and the axial lobe is 17 mm. wide at the front. The pygidium is 16 mm. long, and 20 mm. wide.

This species is most closely allied to *Bumastus billingsi* Narraway and Raymond and differs only in possessing a small median tubercle, fainter and straighter dorsal furrows, and in the very punctate appearance of the internal cast of the cephalon and pygidium. These puncta have not, however, been seen on specimens from localities other than Trenton Falls, N.Y. Specimens retaining the test resemble *B. porrectus,* the lunettes being faint and the posterior portions of the dorsal furrows concealed, but the entire animal is less slender and there is a greater disparity between the sizes of the cephalon and pygidium.

Horizon and Locality: — The M. C. Z. contains five more or less complete specimens from the Trenton at Trenton Falls, collected by Dr. C. D. Walcott many years ago, but it is not by any means common there. In the Kimmswick at Mincke, St. Louis Co., Mo., it seems to be one of the most common trilobites and numerous detached shields were collected there and at Glencoe, Mo., by Dr. D. C. Barton. The plesiotype (M. C. Z. 715) is from Trenton Falls. Dr. Foerste's specimens, which have been described since the above was written, were found in the Kimmswick limestone on Sanders Branch, Ralls Co., Mo.

Bumastus globosus (Billings).

Illaenus globosus Billings, Canad. nat. geol., 1859, **4**, p. 367, fig. 1–3. Geol. Canada, 1863, p. 133, fig. 64a–c. Raymond, Ann. Carnegie mus., 1905, **3**, p. 350, pl. 13, fig. 6, 7. Grabau and Shimer, N. A. Index fossils, 1910, **2**, p. 294, fig. 1605a–c.

Bumastus globosus Raymond, Ann. Carnegie mus., 1910, **7**, p. 71, pl. 19, fig. 9. 7th rept. Vermont state geol., 1910, p. 228, pl. 35, fig. 6, 7; pl. 39, fig. 9. Proc. and Trans. Roy. soc. Canada, 1912, ser. 3, **5**, sec. 4, p. 120, pl. 3, fig. 3.

This is one of the most common trilobites in the Chazy along Lake Champlain, and is equally abundant in the typical locality for the species, the Mingan Islands. Its very abundance has produced a tendency to rather loose reference of all Chazyan bumastids to this species.

As with other members of the family, the dorsal furrows are very characteristic of the species. Billings states that on the type they extend only one third the length of the cephalon, which is true if he had reference to a measurement over the curvature, but not if compared

with the actual length, of which they equal about one half. Billings's description of them as subparallel is also true only in a most general sense, for they are distinctly convergent in all specimens. Each furrow is approximately straight through the greater part of its course, but turns outward at both ends. On some the furrows appear straighter and more nearly parallel than others, the differences arising largely from the shape and depth of the lunules, and the presence or absence of the dorsal test.

Billings was unable to make out the outline of the fixed cheeks of his specimens. As shown by material both from the Mingan Islands and Chazy, N. Y., these cheeks are small, but extend outward beyond the eyes. The facial suture turns abruptly outward at the back of the eye, runs nearly parallel to the posterior margin for a short distance, then gradually approaches it.

There is considerable difference in the size attained at different localities. Billings's type seems to be typical of those found at the Mingan Islands, although Professor Twenhofel found one or two cranidia which were larger. Specimens from the Chazy in the Champlain Valley are generally small, but in the reefs at the base of the Upper Chazy, both at Chazy and Valcour Island, numerous large shields are found, some more than twice the size of those from the Mingan Islands.

Measurements: — Billings gives the following measurements of the type: — Length of cephalon (on the curvature) 1 inch (25 mm.), measured from the middle of anterior to middle of posterior margin 9 lines (18 mm.); length of thorax and pygidium, each 9 lines (18 mm.). The largest cranidium from the Mingan is 32 mm. over the curvature, or 23 mm. long. The largest from the reef at Chazy is 40 mm. long and one from Valcour Island has the same length. Measured over the curvature, the latter is 55 mm. long.

Horizon and Locality: — Billings cited this fossil from the "Mingan Islands, and also Island of Montreal, Chazy." Schuchert and Twenhofel report it from zones A 3–5 of the Mingan formation (Upper Chazy) on the Mingan Islands. It is fairly common throughout the Chazy in the Champlain Valley, but most abundant and of largest size at the base of the Upper Chazy.

Small cranidia and pygidia which appear to belong to this species are common in the Lenoir at Lenoir City and one mile east of Bluff City, Tenn.

Bumastus comes, sp. nov.

Plate **7**, fig. 7.

Illaenus globosus Raymond (*non* Billings), Ann. Carnegie mus., 1905, **3**, pl. 13, fig. 6 (*non* fig. 7).

This trilobite occurs commonly in the Chazy associated with *B. globosus*, from which I have not previously differentiated it.

Cephalon highly convex, with steep anterior and lateral profiles. The eyes are small, situated far apart, and close to the posterior margin. The short dorsal furrows are arcuate, arise back of the eyes and run inward on a smooth curve to the narrow lunules, then turn slightly outward. The doublure is strongly striated, and a broad band of terrace lines rises high on the slopes of the cephalon. The test on the upper surface is finely punctate.

Thorax and pygidium unknown.

This species is more likely to be confused with *Bumastus globosus* than any other. Billings stated that the dorsal furrows in that species were subparallel, a little curved outward at the anterior extremities. Specimens from the Mingan Islands agree with this description, but the furrows are not strictly parallel, there being a slight convergence. The median parts of the furrows are nearly at right angles to the posterior margin, whereas in *B. comes*, the furrow is throughout its course decidedly curved. In profile, size, convexity, and proportions, the cephala of the two species are very much alike.

Measurements:— The holotype (M. C. Z. 1,608) is 20 mm. long from front to back (17 mm. in projection), the width is 28 mm.; and the width at the palpebral lobes 23 mm. Two other complete cephala have practically the same measurements.

Horizon and Locality:— All of the specimens which are positively identified as this species (nine in number) are from the pasture three miles east of Chazy, N. Y., near Little Monty Bay.

Bumastus aplatus, sp. nov.

Plate **8**, fig. 3, 4.

Cranidium depressed, convex, smooth, with short, converging, faintly impressed furrows. The palpebral lobes project but slightly, indicating rather long, very narrow eyes. The length is only three fourths the breadth at the palpebral lobes, suggesting a short cephalon.

Free cheeks and thorax unknown.

Pygidium two thirds as long as wide, depressed convex, smooth, with no trace of raised axial lobe. The position of the notches on the anterior border indicate a wide axial lobe in the thorax.

The surfaces of both shields are marked by rather widely scattered, fine puncta.

The dorsal furrows of this species are fainter than those of *B. globosus* and are less nearly parallel. They are not, however, so faint as those of several of the other species described in this paper. The long narrow palpebral lobes suggest *B. longiops*, but the eyes do not appear to have been so long, and, moreover, the dorsal furrows are entirely obsolete in that species.

Measurements:— The cranidium designated as the holotype (M. C. Z. 1,609) is 12 mm. long (11 mm. in projection); and 16 mm. wide between the palpebral lobes. The pygidium of the paratype (M. C. Z. 1,610) is 10 mm. long, and 16 mm. wide. The smallest specimen is 4.5 mm. long (3.5 mm. in projection); and 5.25 mm. wide at the palpebral lobes.

Horizon and Locality:— Cranidia and pygidia of this species are very common in the upper part of the Lower Chazy in Fleury's pasture, on the southwestern part of Isle La Motte, Vt. Three specimens, two cranidia and one pygidium, were found in the Lower Lenoir, one mile east of Bluff City, Tenn.

Bumastus lioderma, sp. nov.

Plate 7, fig. 10, 11.

A large Bumastus for the Ordovician, with large plump shields and slight traces of dorsal furrows.

Cranidium large, very convex, smooth, without traces of dorsal furrows on the test. On the cast there are small shallow lunettes, and a pair of extremely faint narrow furrows run diagonally outward and backward from the lunettes to the posterior margin. The palpebral lobes are small, and close to the posterior margin. Part of a free cheek preserved in one specimen shows that the genal angles are broadly rounded and that the cephalon is constricted on either side in front of the eyes as in many species of Bumastus. The surface is smooth except on the anterior slope, where there are numerous terrace lines which show on the test but not on the cast.

Only unsatisfactory fragments of the thorax have been seen.

The pygidium is large and smooth, without trace of axial lobe.

Measurements:— A cranidium is 45 mm. long (in projection); and

about 62 mm. wide at the palpebral lobes. Another is 33 mm. long in projection, about 55 mm. over the curvature, the palpebral lobes about 43 mm. apart, and the lunettes 22 mm. apart. A small cranidium is 18 mm. long in projection, 23 mm. over the curve, and 25 mm. wide at the palpebral lobes. A pygidium which probably belongs with the first cranidium above is 33 mm. long and 42 mm. wide. Another is 31 mm. long and 39 mm. wide.

This species with its almost complete lack of traces of dorsal furrows on the cephalon and small eyes is very like the *Bumastus porrectus* of the Trenton and differs from that species chiefly in the much greater size of the specimens. It differs from *Bumastus holei* in lacking the small median tubercle on the posterior portion of the cranidium, in having the lunules smaller and farther forward, and the furrows running backward from the lunules diagonally instead of straight. The differences from the other species of Bumastus are too obvious to require comment.

Horizon and Locality:— The species is very common at the type-locality, the McNutt quarry near Sharon Springs, Va., where it occurs in the Holston. It is found in the same formation in the Catawba Valley, north of Salem, Va., and at the Ross Republic quarry, three miles southeast of Knoxville, Tenn. It is also found in the Murat at Lexington, Va., in the Ottosee at Speers Ferry, Va., and the Lenoir, six miles southeast of Knoxville, Tenn. Cotypes (M. C. Z. 1,655–1,657).

Bumastus limbatus Raymond.

Illaenus indeterminatus Raymond (*non* Walcott), Ann. Carnegie mus., 1905, **3**, p. 347, pl. 13, fig. 1, 2.

Bumastus limbatus Raymond, Ann. Carnegie mus., 1910, **7**, p. 71. 7th rept. Vermont state geol., 1910, p. 230, pl. 35, fig. 1, 2.

A single cranidium which is referred with doubt to this species was found in the Lenoir, six miles southeast of Knoxville. It agrees with *B. limbatus* in having a depressed cranidium and very long dorsal furrows, but these furrows are more curved than in the type of *B. limbatus* and more like those seen in small specimens of *B. indeterminatus*. As only a single small specimen has been found, a more exact determination must be left for the future, but the occurrence of this type of Bumastus in the Lenoir is of interest.

Measurements:— The cranidium is 20 mm. long.

Bumastus dispassus, sp. nov.

Plate 7, fig. 6.

Three segments of the thorax and the pygidium represent a species of Bumastus of a type unusual in the Ordovician, but not unlike many of the Silurian species.

The thorax has a wide axial lobe which is elevated considerably above the narrow pleural lobes, the dorsal furrows being so deep as to set off the lobes distinctly. The individual segments are wide.

The pygidium is slightly longer than wide, not highly convex, and possesses a wide concave border. The axial lobe is indicated only at the anterior margin, and the surface is apparently smooth.

Measurements: — Three segments of the thorax, probably the last three, are together 11 mm. long, and about 26 mm. wide. The axial lobe is 30 mm. wide on the middle segment. The pygidium is 34 mm. long, and 33 mm. wide.

The low long pygidium with its wide concave border serve to distinguish this species. *Bumastus indeterminatus* Walcott has a wide concave border on the pygidium and one might predict that the cephalon of *B. dispassus* would probably prove to be depressed convex, with long dorsal furrows like those of *B. indeterminatus* and *B. limbatus*.

Horizon and Locality: — The holotype (M. C. Z. 1,639) was collected by the writer from the Holston marble at Fountain City, Tenn.

Bumastus longiops, sp. nov.

Plate 8, fig. 18, 19.

A small Bumastus with smooth, evenly convex cranidium, very long, narrow, palpebral lobes, no trace of dorsal furrows on testiferous specimens and only faint linear lunules on casts. Thorax unknown.

The associated pygidium is very depressed, almost flat, smooth, and the axial lobe indicated only on the anterior margin.

Measurements: — A cranidium is 9 mm. long (in projection) 12.5 mm. over the curve; and 11.5 mm. wide at the palpebral lobe. The largest cranidium in the collection is 14 mm. long in projection. A pygidium is 9.5 mm. long, and 15 mm. wide.

The large, long, Nileus-like palpebral lobes of this species readily separate it from all other Ordovician species of Bumastus.

Horizon and Locality: — This species is common in the Holston at

the type-locality, the McNutt quarry, Sharon Springs, Va., and a few specimens have been found in the same formation on the Hoge farm, Bland Co., Va., the Ross Republic quarry, three miles southeast of Knoxville, Tenn., and the marble quarry one mile south of Concord, Tenn. Two specimens were obtained from the Murat at Lexington, Va., and a few from the top of the Holston at the Thomas farm, three miles east of Blacksburg, Va. It was collected first by Dr. E. W. Shuler, and later by Dr. R. M. Field and the writer. The cotypes are M. C. Z. 1,647, 1,648.

Proëtidae Corda.

Cyphaspis slocomi, sp. nov.

Plate 8, fig. 9.

Cyphaspis girardeauensis Savage (*non* Shumard), Bull. 23, Ill. geol. surv., 1913, pl. 2, fig. 13.

The cranidium only is known.

Glabella highly convex, the central portion obovate, highest in front of the eyes, bordered by a narrow, deep furrow. Lateral lobes small, oval, two fifths as long as the glabella. Fixed cheeks narrow, dropping abruptly away from the glabella. Frontal border flat, separated from the glabella by a convex ridge of about its own width. Nuchal ring narrow, with a low median pustule.

It is difficult to separate the various species of Cyphaspis. None has hitherto been reported from the Maquoketa, but several appear to be present at a somewhat higher horizon in the basal Silurian (Alexandrian series). *Cyphaspis girardeauensis* Shumard, from the Girardeau limestone, and *C. intermedia* Weller, from the Channahon, are species from that series which are very similar to the one here described. All three have glabellae of what Weller has called intermediate length, that is, about 80 per cent of the total length. The central portion of the glabella of *C. girardeauensis* is wider in front of the eyes than is that of the present species; otherwise there is no recognizable difference between the cranidia. The glabella of *C. intermedia* is of the same shape as that of *C. slocomi*, but the occipital segment of the former is said to be narrow and flat, considerably depressed below the level of the glabella, whereas in the latter it is convex and high with a median tubercle. These differences are admittedly small, but sufficient to permit a separation.

Savage (Bull. 23, Ill. geol. surv., 1913, pl. 2, fig. 13) has figured as an

example of *C. girardeauensis*, a small cranidium which has the glabella so narrow at the front as to agree much better with *C. slocomi* than with the former species.

Measurements: — The cranidium of the holotype (M. C. Z. 1,692) is 2.5 mm. long; the distance from the front of the glabella to the posterior margin is 2 mm., and the glabella is 2 mm. wide in front of the eyes.

Horizon and Locality:— The single specimen was collected by the writer in the Lower Maquoketa on a loose fragment just below the bridge over Sand Creek at Clermont, Iowa.

Lichadidae Corda.

Acrolichas Foerste.

Acrolichas Foerste, Ohio journ. sci., 1919, **19**, p. 402.
Amphilichas Raymond, *partim*.

In a previous paper (Ann. Carnegie mus., 1910, **7**, p. 72) I called attention to the fact already noted by both Schmidt and Reed, that cephala which would answer the definition of Amphilichas were found associated with one type of pygidium in Russia and quite another in America. I remarked "It can hardly be doubted that the cranidia and pygidia found associated in the Chazy belong to the same genus and species, and it is equally unlikely that Schmidt was mistaken in associating the cranidia and pygidia which he referred to *A. lineatus*. The glabella of Amphilichas is one which might have been developed along parallel lines in different sections of the Lichadidae, and it is therefore possible that our American species is not congeneric with *Amphilichas lincatus*."

Foerste describes his genus as follows: —

Cranidia as in the European genus Amphilichas. Pygidia differing as follows: Three pairs of ribs, all with free tips; axial lobe narrowing posteriorly to an acute point which reaches the notch between the free tips of the posterior pair of ribs. Genotype: — *Lichas cucullus* Meek and Worthen.

Although Foerste has done nothing to prove that the American species are not congeneric with the type of Amphilichas, it is quite probable that his new generic name will stand, for in the summer of 1918 Schuchert and Dunbar found the pygidium of *Amphilichas jukesii*, and it proves to be very like that of *A. lincatus* and unlike that of any of the other American species referred to the genus. No com-

plete specimen of *A. lineatus* having been found, there has hitherto been some question about the correct association of cephala and pygidia in the genus.

Acrolichas minganensis (Billings).

Lichas minganensis Billings, Pal. foss. Canada, 1865, **1**, p. 181, fig. 163a, b.
Lichas (Platymetopus) minganensis Clarke, Geol. Minn., 1897, **3**, pt. 2, p. 753.
Platymetopus minganensis Raymond, Ann. Carnegie mus., 1905, **3**, p. 355, pl. 14, fig. 1–3, p. 366, fig. 7, 8.
Amphilichas minganensis Raymond, Amer. journ. sci., 1905, ser. 4, **19**, p. 378. Ann. Carnegie mus., 1910, **7**, p. 72, pl. 18, fig. 6; pl. 19, fig. 13, 14. 7th rept. Vermont state geol., 1910, p. 232, pl. 36, fig. 1–3, pl. 38, fig. 6, pl. 39, fig. 13, 14. Grabau and Shimer, N. A. index fossils, 1910, **2**, p. 308, fig. 1619. Bassler, Bull. 2a, Geol. surv. Virginia, 1909, p. 111, figs. 7, 8, 10. Perkins, 8th rept. Vermont state geol., 1912, pl. 18, fig. 6.
Lichas champlainensis Whitfield, Bull. Amer. mus. nat. hist., 1881, **1**, p. 342, pl. 33, fig. 6–8. Brainerd and Seely, Bull. Amer. mus. nat. hist., 1890, **3**, p. 22.

The original localities for this species cited by Billings were the island of Montreal and the south side of Large Island, Mingan Islands. I have before me four cranidia, collected by Professor Twenhofel on Bald Island, Mingan Islands, in the coarse-grained white limestone of zone A_5 of Schuchert and Twenhofel's section (Bull. Geol. soc. Amer., 1910, **21**, p. 692). These are somewhat more perfect than the cotypes figured by Billings and afford some additional information about specimens from the typical region.

They show that the furrows which delimit the central lobe are not exactly straight, but show a slight deflection toward the side lobes at about the horizon of the eyes. Neither do these furrows reach the neck-furrow at exactly a right angle, there being a slight outward bend in the last 1 or 2 mm. of the course. The dorsal furrows turn very far out behind the eyes, making the side lobes roughly kidney-shaped. The ornamentation is rather uniform on the four specimens, consisting of low rounded tubercles of about three sizes, none very large or conspicuous. The largest tubercles seem to be spaced about their own diameter apart, with the smaller ones in more or less regular rings around them. Associated with the cranidia are two hypostomata of the usual form for the genus. Their surfaces are smooth.

This same species is quite common in the Holston in the Catawba Valley, north of Salem, Va., where both cranidia and pygidia were found. The cranidia show the same characteristics as those from the

Mingan Islands. The pygidia agree with the ones found in the Champlain Valley. The axial lobe shows two rings, and tapers to a point behind, while the pleural lobes show three broad ribs with free pointed ends.

Measurements:— A cranidium from Bald Island, Mingan Islands, is 23 mm. long, 28 mm. wide at palpebral lobes; and the median lobe of the glabella is 8 mm. wide at the horizon of the eyes. Another cranidium from the same locality is 26 mm. long.

A cranidium from the Catawba Valley is 28 mm. long, 34 mm. wide at the palpebral lobes, and the median lobe is 9.5 mm. wide at the horizon of the eyes. A pygidium from the latter locality is 26 mm. long, about 37 mm. wide, and the axial lobe is 14 mm. wide at the front.

Horizon and Locality:— Besides the localities cited by Billings, which are both in the Upper Chazy, this species occurs in the Middle and Upper Chazy in the Champlain Valley, and, as recorded above, in the Holston in the Catawba Valley. The species also occurs in the Holston at the McNutt quarry, in Bland Co., Va., whence we have three cranidia, one collected by Dr. Shuler. A single pygidium from the Ottosee east of the quarries at Saltville, Va., may belong to this species, but is too poorly preserved for accurate identification.

Bassler has reported it from the Liberty Hall at Lexington, Va., and there are fragments of an Acrolichas, possibly this species, in the upper part of the Holston zone with agnostids, three miles east of Blacksburg, Va.

Acrolichas prominulus, sp. nov.

Plate 8, fig. 11, 12.

In the Holston at the McNutt quarry, Dr. Shuler found two imperfect cranidia which differ from all other species of the genus in having the anterior end of the glabella somewhat drawn out and compressed laterally. The courses of the glabellar and dorsal furrows are practically the same as in *Acrolichas minganensis,* but the surface is rougher than in that species because certain irregularly placed tubercles are considerably larger than the others.

The prominent anterior end of the glabella of this species suggests *A. cucullus* (Meek and Worthen) but the dorsal surface shows no such transverse depression as is developed in that form.

Two hypostomata found in the same quarry with these cranidia, differ from the hypostoma of *A. minganensis* in having much less elevated mounds on the proximal ends of the side wings, and they are

therefore referred to this new species, though with considerable reservation.

Measurements: — The more complete cranidium, a fragment of a large specimen, was apparently about 38 mm. long, and about 48 mm. wide at the palpebral lobes. The smaller cranidium was about 28 mm. long when complete.

Horizon and Locality:— This species has so far been found only at the McNutt quarry, near Sharon Springs, and on the Hoge farm, both in Bland Co., Va. The cotypes are M. C. Z. 1,753, 1,754.

Amphilichas jukesii (Billings).

Lichas jukesii Billings, Pal. foss. Canada, 1865, **1**, p. 282, fig. 269a, b, p. 335, fig. 323a, b.

The type of Amphilichas is *Platymetopus lineatus* Angelin (Pal. Scandinavica, 1854, **1**, p. 75, pl. 38, fig. 12, 12a), a species so poorly described and figured by its author that were it not for Schmidt's researches it would be absolutely unrecognizable. The cephalon is very simple for a lichad, the first pair of furrows extending back to the neck-furrow, and cutting the glabella into three plain lobes. This is the same type of cephalon as in the common American Acrolichas, but the pygidium found by Schmidt associated with it is much shorter than that of Acrolichas, has the pleural lobes extended as blunt points only, not in free ribs, and the axial lobe merges into the general surface. Professors Schuchert and Dunbar found a pygidium of this sort associated with cephala of *Lichas jukesii*, showing that it is a true Amphilichas.

The cephalon of this species is somewhat peculiar, for although the majority of the specimens have glabellar furrows like those of Amphilichas, certain specimens have the composite lateral lobes indented or even divided, as in some specimens of Oncholichas. There is usually a faint depression crossing each lateral lobe from the middle of the inner side to the palpebral lobe, and in some young specimens this is a distinct furrow, as in the specimen from Stanbridge, figured by Billings. The eyes are very large and prominent, situated close to the furrows.

Horizon and Locality:— This species was first described from the conglomerates of division P at Cow Head, Nfld., and later reported by Billings as abundant on lot 20, range 6 of Stanbridge, Quebec. Schuchert and Dunbar found it to be common in pebbles of the Cow Head conglomerate at Lower Head, Nfld.

Platylichas inconsuetus, sp. nov.

Plate 6, fig. 12.

Cranidium (only portion known) large, convex, pentamerously lobed, the anterior lateral lobes standing higher than the median or middle laterals. The anterior furrows extend back to the occipital furrow, being nearest together a short distance in front of it, where they join the third lateral furrows, which in turn, circling the back of the anterior lateral lobes, run forward to the dorsal furrows, which they reach in front of the eyes. Outside the anterior lateral lobes is a pair of smaller, but convex and prominent lobes, which are believed to be a combination of the middle laterals with the lobes of the fixed cheeks, and outside them, at a lower level, are the palpebral lobes, poorly preserved on both sides. Very large occipital lobes are present, situated largely back of the outer lobes. The occipital furrow is broad and deep, and the neck-ring broad. The facial suture cuts the posterior margin inside the genal angle.

Measurements:— The specimen is 30 mm. long, about 41 mm. wide between the eye-lobes, and about 47 mm. wide at the fixed cheeks. The convexity is about 15 mm.

Horizon and Locality:— The type (M. C. Z. 1,728) was collected by the writer from the Glens Falls limestone (basal Trenton) just above the bridge at the falls of Sprakers Creek, one mile south of Sprakers, N. Y.

Hemiarges bartoni, sp. nov.

Plate 8, fig. 10.

The genus Hemiarges was erected by Gürich (Neues jahrb. beil. bd., 1901, **14**, p. 526) for lichads of the type of *Arges wesenbergensis* Schmidt with two pairs of bicomposite lateral lobes on the glabella.

The cranidium here referred to this genus is small, elevated, and spinose. The median lobe of the glabella is narrow, highest at the front, and covered with spines and tubercles, five of which are more conspicuous then the remainder. The anterior lateral lobes are conspicuous mounds, each with a pair of spines. The posterior lateral lobes are somewhat triangular, becoming inflated away from the axial region, and covered with small pustules. The palpebral lobes are well back and distant from the axis.

This species resembles the type of the genus, but is much more

elevated and spinose. The median lobe is narrower and more spinose than that of *Hemiarges paulianus* (Clarke) and the greatest affinity seems to be with *H. tuberculatus* (Weller) from the Black River in New Jersey (Pal. N. J., 1903, **3**, 199, pl. 15, fig. 11–13). From that species it appears to differ in having larger and more regularly placed spines.

Measurements: — Length of cranidium, 6 mm., width at palpebral lobes, 8.75 mm.

Horizon and Locality: — The single specimen (M. C. Z. 1,755) was collected in the Kimmswick limest one at Mincke, Mo., by Dr. D. C. Barton.

Odontopleuridae Burmeister.

Onychaspis, gen. nov.

When revising the genera of the Odontopleuridae recently (Ottawa nat., 1916, **29**, p. 135) I did not foresee the almost immediate need which has arisen for a name for odontopleurids of the same type as Ceratocephala, but in which the free cheeks are not fused to the cranidium. That a species of this type should be found in the Ordovician is not at all surprising, since the true Ceratocephalae are all Silurian and were probably preceded by species in which the cheeks were not anchylosed. Type: — *Onchaspis confraga*, sp. nov.

Onchaspis confraga, sp. nov.

Plate **8**, fig. 13.

Only the cranidium and a free cheek of this species have been found. They indicate a trilobite of small size with a cephalon of the same general pattern as Ceratocephala, but with separable free cheeks. There are no dorsal furrows, but the glabella is roughly blocked off from the low, convex, fixed cheeks by the glabellar furrows, two pairs of which are short and deeply impressed, placed diagonally to the axis, while the first pair is represented merely by a pair of pits very close to the anterior end of the glabella. The glabella thus roughly limited is somewhat rectangular, with lateral projections, narrow, and not greatly elevated. The palpebral lobes are damaged, but the eyes seem to have stood about midway in the head and not so far forward as in Ceratocephala. The neck-ring bears a median tubercle and a pair of large spines extending upward and backward. They are

longer and more like those of Ceratocephala than would be indicated by the figure on Plate 8. On the glabella and cheeks there are a few tubercles of various sizes and, judging from the bases, there were two rather conspicuous spines at about the center of the glabella. The free cheek is bordered on the outer margin with short stout spines extended in an horizontal plane.

Measurements: — The cranidium, without the spines, is 5.5 mm. long; and the glabella is 2.25 mm. wide.

I do not know any species with which this can profitably be compared. The only species in the Chazy, *Odontopleura narrawayi* Raymond, has two divergent spines on the occipital ring, but has a quite different type of glabella.

Horizon and Locality: — A very rare trilobite at the top of the Holston at the Thomas farm, three miles northeast of Blacksburg, Va. Holotype (M. C. Z. 1,613).

Glaphurus decipiens, sp. nov.

Plate 8, fig. 20.

Cephalon short, convex, with the glabella rising high above the cheeks. Glabella ovate, entirely encircled by narrow but deep dorsal furrows. The only glabellar furrows shown by most specimens are the posterior ones, which are represented by a pair of deep pits. Occasional specimens show the first and second pairs of furrows very faintly. The eyes are small, situated close to the dorsal furrows and about half way to the front of the head. The facial suture cuts the genal angle, runs forward and inward to the eye, and then downward and outward to the anterior lateral margin. In front of the glabella is a narrow furrow and an equally narrow convex rim. The whole surface is covered with irregularly dispersed pustules, but no spines are preserved, if any were ever present.

No parts of the thorax or pygidium have been found.

Measurements: — The largest cranidium from the Mingan Islands is 11 mm. long, and 17 mm. wide. The glabella is 8.25 mm. long, (without occipital segment) and 9 mm. wide at the base. The cranidium from the Catawba Valley is 8 mm. long; the glabella 6 mm. long, and 6.5 mm. wide at the base.

This species differs from the *Glaphurus pustulatus* (Walcott) of the Champlain Valley in having only the posterior glabellar furrows well developed and apparently in lacking spines and having a much nar-

rower border in front of the glabella. On the last two points I am not absolutely certain as these apparent differences may possibly be due to the state of preservation. The pustules are also less regularly arranged on the glabella of this species than on that previously described.

Horizon and Locality: — Four cranidia were collected by Professor Twenhofel in zone A_5 on Bald Island, Mingan Islands, and I obtained a cranidium from the Lower Lenoir at Bluff City, Tenn., and another from the Holston limestone in the Catawba Valley, north of Salem, Va. The holotype is from the Mingan Islands and is in the Yale University Museum.

Acidiphorus, gen. nov.

This genus includes two species of trilobites which are known chiefly from the pygidia, hence its place in the classification is doubtful. They are small and the axial lobe of the pygidium extends across the margin and is prolonged into a conical spine from two to three times as long as the shield.

Genotype: — *Acidiphorus spinifer*, sp. nov.

This genus differs from Goniurus (Bull. 1, Victoria mem. mus., 1913, p. 65) in that the terminal spine is a prolongation of the axial lobe and margin of the pygidium, instead of the latter alone. It is not probable that it belongs to any of the established families.

Acidiphorus spinifer, sp. nov.

Plate 8, fig. 15, 17.

Pygidium short, narrow, very convex. The axial lobe, instead of having its axis in a plane parallel to that of the margin, as in most trilobites, slopes downward and backward, and continues across the margin to form a spine about twice as long as the shield proper. This spine is ornamented with raised longitudinal lines which give it a somewhat fluted appearance. The anterior end of the axial lobe has five rings, and an ornamentation which suggests V-shaped scales.

The pleural lobes are narrow, steep and somewhat concave. Each has one furrowed rib beside the anterior half-rib.

Horizon and Locality:— Schuchert and Twenhofel collected a pygidium at their locality 3100–8, zone 11, Point Rich, another at locality 3100–9, zone 11, and a third, the holotype, in the Leperditia bed at Table Head, Nfld. The type is in the Yale University Museum.

ACIDIPHORUS SCORPIONIS, sp. nov.

Plate 8, fig. 16.

This species differs from *A. spinifer* in having a pygidium with a somewhat wider axial lobe which has no rings except the one at the anterior end. The outline, disregarding the terminal spine, is less triangular, and the pleural lobes less steep.

Measurements:— The holotype (M. C. Z. 1,756) has the main shield of the pygidium 2.25 mm. long, and the spine extends 5.25 mm. beyond the margin, the width is 3.00 mm., and the axial lobe is 1.50 mm. wide at the front.

On the same fragment of rock with two pygidia of this sort there are two cranidia of *Bathyurus breviceps* Billings (Pal. foss. Canada, 1865, **1**, p. 262, fig. 346), as well as specimens of *Remopleurides affinis* Billings and *Arthrorhachis galba* (Billings). It may be that this pygidium is that of "*Bathyurus*" *breviceps*, in which case the specific name *scorpionis* must be given up, but the generic name Acidiphorus may be retained, since no known genus has such a combination of cephalon and pygidium.

Bathyurus breviceps has previously been known only from cranidia found in division N at Table Head, Nfld. The original specimens and those found at Mystic are small, evenly convex, and about the proper size and shape to associate with the pygidia already described. The glabella is moderately convex and smooth, without furrows, and the cheeks broad, gently convex, united in front of the glabella by a very narrow ridge. The eyes are small, situated far back and far apart. There is a narrow upturned frontal border.

Horizon and Locality:— Two specimens of the pygidium were found in a boulder in a conglomerate on lot 22, concession VI, of Stanbridge, Que., about two miles northeast of Mystic Station. The boulder contained numerous trilobites of Normanskill types.

PROPARIA Beecher.

ENCRINURIDAE Angelin.

ENCRINURUS NODOSARIUS, sp. nov.

Plate 8, fig. 14.

Like many species of the genus, this one is known from the pygidium only. That shield is of small size, slightly broader than long, and the first four pairs of ribs cross the border and end in short rounded spines.

The axial lobe has ten distinct rings which run entirely across it, and behind the distinct rings several more which are so close together that they cannot be counted. The pleural lobes have six pairs of ribs. The first four pairs cross the border and end in short rounded spines whereas the last two pairs turn back parallel to the posterior end of the axial lobe and their outer ends do not cross the border. The rings and ribs are both minutely pustulose, but the pustules are so small that they are only seen when the specimen is held at certain angles.

Measurements:— Length of pygidium 3.5 mm., width 4.25 mm. Width axial lobe at front 1.5 mm.

The older Ordovician species of Encrinurus are *E. rarus* (Walcott), *E. trentonensis* Walcott, *E. tuberculosus* Collie, *E. vannulus* Clarke, *E. vigilans* (Hall), and *E. varicostatus* Walcott. The name of the last species was unfortunately misprinted *raricostatus* by Clarke and so continued in Bassler's bibliography.

Encrinurus rarus, originally described as a Ceraurus, is known only from a fragmentary cephalon, but is probably the same species as *E. vannulus* Clarke. *E. vannulus* and *E. varicostatus* both agree with the form just described in having only six pairs of pleural ribs. Neither of these species is, however, tuberculated. *E. vannulus* has, moreover, only six to seven distinct rings on the axial lobe whereas *E. nodosarius* has ten and only three pairs of ribs have free endings. *E. varicostatus* is probably most closely allied to *E. nodosarius*, but besides lacking pustules on the surface, five pairs of the ribs end in spines, and the ribs are much broader than in our species. *Encrinurus vigilans* and *E. trentonensis* both have nine pairs of ribs on the pleural lobes, and *E. tuberculosus* has eight pairs, and the great number of twenty-five distinct rings on the axial lobe.

Horizon and Locality:— The single specimen (M. C. Z. 1,614) on which this species is founded was found in the Lenoir, about six miles southeast of Knoxville, Tenn., on the same piece of limestone as a specimen of *Pliomerops canadensis*.

Cybeloides iowensis Slocom.

Plate **9**, fig. 8.

Cybeloides iowensis Slocom, Bull. Field mus. nat. hist. Geol. ser., 1913, **4**, no. 3, p. 64, pl. 16, fig. 1–4. Ann. rept. Geol. surv. Iowa, 1916, **15**, p. 213, pl. 17, fig. 1–4.

The pygidium of the type of this species was so poorly preserved that it was neither figured nor described in detail. Four pygidia were

obtained by the writer from the Maquoketa, one from the typical locality for the species, Elgin, Iowa, and three along a stream four miles west of Clermont.

The pygidium is narrow, highly vaulted, subtriangular, acutely rounded behind. The axial lobe is about one half the total width, and tapers regularly backward, extending nearly to the posterior end, where it descends gradually to the general surface. It is crossed by but one complete ring, that at the anterior end, but is indented at the sides by about fourteen pairs of oblique pits, and has on the top six pairs of small sharp tubercles.

The ring at the anterior end of the axial lobe bifurcates on the pleural lobes producing on either side a pair of elongate ribs which curve around parallel to the margin, closely approaching the axial lobe at its posterior end. The outer rib of each pair is marginal, and the inner one parallels it. Between this latter ridge and the axial lobe there is on either side a space covered by less conspicuous ribs. The pair nearest the axial lobe are short, start back of the middle, and extend to the posterior end, separated from the axial lobe by a very narrow furrow. Just outside these lie another pair which extend nearly the whole length of the pygidium about parallel to the axis, but deflected somewhat where they embrace the ribs just mentioned. Another very faint rib intervenes on either side between the long one and the inner of the marginal pair.

Rounded tubercles are scattered sparsely over the surface, particularly along the ribs.

Measurements: — The pygidium described and figured is 7 mm. long, 6 mm. wide; and the axial lobe is 2.75 mm. wide at the anterior end.

The pygidium differs from that of other known species of this genus in that none of the pleural ribs ends in a free spine, and the lateral lobes have fewer ribs. The nature of the pygidium shows conclusively that *Cybeloides iowensis* is quite distinct from *C. winchelli* (Clarke).

Cybeloides, sp. ind.

A single glabella of a Cybeloides was found at the base of the reef in the Holston on the Hoge farm, Bland Co., Va. It is too imperfect for specific identification, but is sufficient to indicate the presence of this genus in the Holston. This glabella resembles that of *Cybeloides prima* (Raymond) of the Chazy in having three pairs of glabellar furrows developed as pits along the sides, but the surface appears to be less pustulose. The single glabella is 3.5 mm. long.

Cybele mira (Billings).

Encrinurus mirus Billings, Pal. foss. Canada, 1865, **1**, p. 292, fig. 282.
Cryptonymus mirus Vogdes, Mon. genus Zethus, 1878, p. 34.
Cybele mirus Clarke, Geol. Minn., 1897, **3**, pt. 2, p. 743.

Specimens collected by Schuchert and Twenhofel add a little to what has previously been known of this species. The cephalon has a pair of rather long, thick, and strongly divergent genal spines, but the presence of three pairs of straight lateral furrows and no longitudinal furrows on the glabella show that this is a true Cybele and not a Cybeloides. Both the cranidia show the median furrow in the frontal lobe and the very curious branching of the anterior lateral glabellar furrows mentioned by Billings. The pygidium has four pairs of double ribs, the anterior half of each rib being much higher and wider than the other. This produces an appearance of an alternation in size of ribs which does not seem to occur in Cybeloides, but is to be observed in the Russian species of Cybele. All of the rings on the axial lobe seem to run entirely across, which is unusual in Cybele, and unknown in Cybeloides.

Measurements: — The largest glabella is 6 mm. long, 4 mm. wide at the back and 6 mm. wide at the front. A small cephalon is 4 mm. long, and 10 mm. wide, not including the genal spines. A pygidium is 10 mm. long, and 11 mm. wide.

Horizon and Locality: — Billings reported this species from horizon N, Table Head and Pistolet Bay, and P, Portland Creek, Nfld. Professors Schuchert and Twenhofel obtained specimens in their horizons N_1 and N_2 at Table Head. Professor Hyatt collected a rather poorly preserved thorax, retaining parts of fifteen segments, and a very poorly preserved pygidium, on the western side of Gargamella Cove, Nfld. All are from the horizon of the Normanskill.

Ectenonotus Raymond.

Ectenonotus Raymond, Bull. M. C. Z., 1920, **64**, p. 279.

Among the anomalous trilobites described by Billings was one which had a glabella very like that of a Pliomerops, and a pygidium strongly suggestive of Encrinurus. Although no entire specimens have been reported the "glabella and pygidium were found in about equal numbers together, and in great abundance. Out of one small piece of rock scarcely a yard in length, there were taken twenty-seven speci-

mens of the glabella, and twenty-four of the pygidium. In this mass of rock there was no other head to which the pygidium could be referred, nor any other pygidium to which the head could possibly have belonged."

The pygidium is distinctly Encrinurus-like in its elongate narrow form, very long axial lobe with numerous rings, and particularly in the way in which the posterior ribs on the pleural lobes curve back around the end of the axial lobe. The pygidium shows some differences from both Encrinurus and Cybele, but they are of a relatively minor character, and if it were not for the associated cranidium, the species would undoubtedly be admitted to the genus Encrinurus.

Although the cephalon is Pliomerops-like, certain encrinurid characteristics may be seen in it, particularly when compared with Cybele. The form of the glabella and position of the glabellar furrows is similar to what is seen in *Cybele bellatula* (Dalman) (Schmidt, Mem. Acad. imp. sci. St. Petersburg, 1881, ser. 7, **30**, p. 203, pl. 13, fig. 9) and the glabella does not expand toward the front as in Pliomerops. The most important point, however, is that the eye is not situated close to the glabella as in Pliomerops. The eye is not shown in any of the specimens but enough of the fixed cheek is preserved to indicate that, whether the eye is ultimately found to be far forward, as in Encrinurus and some species of Cybele, or far back as in other species of that genus, it must at least be placed at some distance from the glabella and thus be encrinurid in position.

Billings made the cranidium the holotype of the species *Amphion-westoni*, so that in case it should prove that the cranidium and pygidium do not belong together, the pygidium will belong to an unnamed species. I propose to designate the specimen from Newfoundland retaining the thorax and pygidium as the holotype of the genus, in order that there may be in the future no uncertainty as to how the names should apply.

Encrinuridae with pygidia whose simple pleural ribs do not end in spines, and whose glabellae have a pair of furrows which emerge on the front instead of the lateral border.

Type: — *Eetenonotus westoni* (Billings).

Another species is *E. octocostatus* (Reed) from Glensaul district in Ireland.

Ectenonotus westoni (Billings).

Amphion westoni Billings, Pal. foss. Canada, 1865, **1**, p. 321, fig. 307a, b.

The best specimen from Newfoundland has twelve segments of the thorax and the pygidium preserved. The specimen is long and narrow, and does not taper rapidly. The axial lobe of the thorax makes up about one third the width and is only moderately elevated. The pleural lobes are rounded and turned down abruptly at the sides. Each pleuron is divided by a shallow narrow furrow into an anterior and posterior portion, the latter about twice as broad and somewhat higher than the former. Near the dorsal furrow there is a pair of low mounds on the proximal ends of both adjoining pleural rib and axial ring.

The axial lobe of the pygidium is long and narrow, with about twenty-one rings. The pleural lobes slope away to the borders and are crossed by ten pairs of simple ribs, the last four of which turn back approximately parallel to the axial lobe and behind it the corresponding ones on opposite sides turn toward each other, so that they meet on the posterior border.

Measurements:— Billings states that the largest glabella in his collection is 10 lines (20 mm.) long, and 7 lines (14 mm.) wide. The pygidium he figured is 26 mm. long, and 26 mm. wide at the front, the axial lobe being 8.5 mm. wide at the anterior end.

The specimen from Newfoundland retaining thorax and pygidium is 36 mm. long, the pygidium 15 mm. long.

Horizon and Locality:— Billings's original specimens were from the "Quebec group" at Stanbridge, Que., where it was found associated with several other curious trilobites, a few of which have since been found in strata of the typical Chazy of the Champlain Valley, but most of which are still little known. It is fairly common in boulders in a conglomerate two miles north of Mystic, Que.

The specimens from Newfoundland were found by Professors Schuchert and Twenhofel at Point Rich in their zone 11 (3100–8), associated with *Pliomerops barrandei*, *Bathyurellus validus*, *Illaenus fraternus*, and other trilobites. More recently Professors Schuchert and Dunbar have collected it on the south shore of East Bay near Port au Port, and at Twohill Point, Port Saunders, Nfld. All specimens are pygidia and fragments of the thorax. The horizon is Normanskill.

Ectenonotus octocostatus (Reed).

Pliomera pseudoarticulata Reed (*non* Portlock), Quart. journ. Geol. soc. London, 1910, **66**, p. 276, pl. 22, fig. 5, 6.
Encrinurus octocostatus Reed, Ibidem, p. 277, pl. 32, fig. 4a, b.
Encrinurus sp. Reed, Ibidem, 1909, **65**, p. 147.

Reed, in his study of the fragmentary trilobites of the Glensaul district (Ireland) was confronted with the same curious association of a Pliomera-like cephalon and an Encrinurus-like pygidium that Billings had experienced in the case of *Amphion westoni*. He compared the cranidium with that of *Amphion westoni*, but because of another pygidium, assigned his specimens to *Pliomera pseudoarticulata* (Portlock). This latter species is known from pygidia only, and both cranidia and pygidia cited above being so like the American *Ectenonotus westoni*, it seems probable that they belong together.

The cranidium assigned to *E. octocostatus* is wider at the genal angles than *E. westoni*, but the glabellae of the two are alike in shape and position of furrows. The position of the eye is not shown. The pygidium has eight pairs of ribs on the pleural lobes, the last pairs turning backward and uniting with the axial lobe, as do those of *E. westoni*. The latter, however, has two or three more pairs of ribs.

Horizon and Locality:— This species was found in a calcareous ash on the Glensaul River, near Garranangerra, County Galway, Ireland.

Calymenidae Milne-Edwards.

Calymene, sp. ind.

The presence of this genus in the upper layers of the Holston at the prolific locality northeast of Blacksburg is of considerable interest, but the three pygidia and one glabella collected are not sufficient on which to base a species in so difficult a genus. All the fragments indicate a trilobite of very small size. The glabella is finely tuberculated and shows three pairs of furrows, the first pair very near the front, short, and faint. The others are deeply impressed and bound glabellar lobes of the form usual in the genus. The best preserved pygidium shows four rings on the axial lobe and four pairs of ribs on the pleural lobes, each rib with a narrow impressed line extending the full length. The ribs extend quite to the margin and the whole surface is tuberculated. Except for their small size, these fragments

show, so far as they are preserved, the specific characteristics of the common *Calymene senaria*.

Measurements: — The single glabella is 5 mm. long, 3.5 mm. wide at the front, and about 4.5 mm. wide at the basal lobes. The best pygidium is 3.25 mm. long, and 4 mm. wide. The other two pygidia are each 4 mm. long.

Horizon and Locality: — So far found only in the top of the Holston, three miles northeast of Blacksburg, Va.

Cheiruridae Salter.

Ceraurus granulosus Raymond and Barton.

Ceraurus pompilius Raymond (*non* Billings), Ann. Carnegie mus., 1905, **3**, p. 365 (*non* fig. 6), pl. 14, fig. 14. 7th rept. Vermont state geol., 1910, p. 240, pl. 36, fig. 14.

Ceraurus granulosus Raymond and Barton, Bull. M. C. Z., 1913, **54**, p. 536.

A Ceraurus which seems to belong to the above species is common in the upper part of the Holston at the well-known locality three miles northeast of Blacksburg, but all the specimens we obtained were very fragmentary.

The glabella of the Virginian specimens is nearly parallel-sided, the basal lobes are more or less quadrangular, and the surface is granulose rather than pustulose. All these characteristics are like those of *C. granulosus*. The genal spines have not been seen. Nearly all the glabellae are exfoliated, in which condition they of course suggest Ceraurinus.

The associated hypostoma is of the usual form for the genus, narrow, strongly convex, and moderately pustulose.

No part of the thorax has been seen and only one pygidium. That is short and wide, the great spines both broken, but strongly divergent and between the great spines the posterior margin is angulated by two pairs of very short blunt spines.

Measurements: — A large cranidium is 6.5 mm. long; and the glabella 4.5 mm. wide at the back and 5 mm. wide at the front. An hypostoma is 5.5 mm. long, 5 mm. wide; and the body is 3.25 mm. wide.

Horizon and Locality: — This species is found near the top of the Middle Chazy and at the base of the Upper Chazy on Valcour Island, N. Y., and at the top of the Holston at the Thomas farm, three miles northeast of Blacksburg, Va. A single glabella was found in the Liberty Hall at Lexington, Va., and another in the Lower Lenoir at Bluff City, Tenn.

Ceraurus hudsoni Raymond.

Ceraurus hudsoni Raymond, Ann. Carnegie mus., 1905, **3**, p. 367, pl. 14, fig. 15. 7th rept. Vermont state geol., 1910, p. 240, pl. 36, fig. 15. Raymond and Barton, Bull. M. C. Z., 1913, **54**, p. 535.

A well-preserved cranidium indicates the presence of this species in the Ottosee. The specimen agrees with *C. hudsoni* rather than *C. pleurexanthemus* Green in having a more rapidly expanding glabella, and in lacking any arrangement of pustules in rows pa rallelto the axis. The genal spines flare widely as in both the species mentioned.

Measurements: — The cranidium is 14 mm. long, 32 mm. wide at the nuchal furrow, not including the genal spines. The glabella is 10.5 mm. wide at the frontal lobes, 8 mm. wide at the basal lobes, and is 10 mm. long, exclusive of the nuchal segment.

Horizon and Locality: — This species has previously been found only at the top of the middle Chazy on Valcour Island, N. Y.

The specimen mentioned above was found in the Ottosee near Tilsons Gap, Bland Co., Va.

A Ceraurus which seems to belong to this species has been found in the Holston on the Hoge farm, Bland Co., Va., and in the Catawba Valley, north of Salem, Va., also in the middle Ottosee, seven miles north of Mendota, Va. The glabella is strongly pustulose and expands toward the front. The specimens are, however, too few and fragmentary to make the identification certain.

Ceraurus angustus, sp. nov.

Plate **8**, fig. 22.

Cephalon long and narrow for the genus, highly vaulted, with steeply sloping cheeks. A second specimen indicates that the genal angles were drawn out into broad spines, which are, however, absent from the type.

As viewed from above, the glabella occupies about one third the width, is moderately convex, smoothly rounded in front, the sides parallel. Glabellar furrows as usual in Ceraurus, the last pair somewhat oblique, so that the basal lobes are not exactly rectangular. The surface is covered with small sharp pustules and granules.

Cheeks small, covered with small circular pits with intervening anastamosing ridges, on which are small, rounded granules. Eyes large, opposite the second and third glabellar lobes, and nearer the

dorsal than the nuchal furrow. Nuchal segment narrow, with granulose surface.

Measurements: — The holotype (M. C. Z. 1,724) is 12 mm. long, and about 22 mm. wide at genal angles (without spines). The glabella is 9 mm. long, 8.25 mm. wide at the frontal, and 8 mm. wide at the basal lobes. Width at palpebral lobes about 15 mm.

This is a remarkably narrow Ceraurus, and were it not for the shape of the glabella, would suggest a Cyrtometopus. This characteristic readily distinguishes it from other species. The glabella alone might be confused with that of *C. granulosus*, having the same shape and ornamentation, but it lacks the square basal lobes of that species. *Ceraurus ingricus* Schmidt and *C. glaber* Angelin are similar narrow forms in northern Europe.

Horizon and Locality: — Dr. E. W. Shuler collected three cranidia of this species from the Ottosee at Tilsons Gap, Bland Co., Va.

Ceraurus tenuicornis, sp. nov.

Plate 8, fig. 23.

This species is based on a single well-preserved pygidium found at about the middle of the Athens. It is remarkable for the reduction of all parts except the great spines, the posterior margin between them being almost straight. The anterior segment of the pygidium is almost entirely free from it and is a short narrow segment with short slender pleural spines. The axial lobe behind this has three rings, the first connecting the great spines, and the other two in the very short area behind. The third one is so reduced as to be a mere pustule. The great spines are long, slender and curve slightly outward near the tips. The surface is covered with fine granulations.

Measurements: — Length of central portion, 1.5 mm., length over all, 10 mm.

It is barely possible that this pygidium may prove to belong to *Ceraurus granulosus*, but it is not in agreement with the pygidium found near Blacksburg associated with glabella referred to that species. The ornamentation, if the same on the cephalon as on the pygidium, would be even more delicate in the cephalon of this species than in *C. granulosus*.

This specimen exhibits a greater reduction of the axial part of the pygidium than in any other known species of Ceraurus, and this tendency is here carried almost to the same extreme as in the Deiphon

of the Silurian. It is of interest to note that the culmination of this tendency was reached at approximately the same time (Upper Chazy) as the greatest development of the opposite type of pygidium, as seen in *Ceraurus ruedemanni* Raymond from New York.

Horizon and Locality: — This species is so far known only from a single pygidium (M. C. Z. 1,664) found beside the railroad track two miles north of Bullsgap, Tenn., in material brought from the cutting one mile south of Otes. The horizon seems to be in the middle of the Athens.

Ceraurus ruedemanni Raymond.

Plate **9**, fig. 1.

Ceraurus ruedemanni Raymond, Bull. 189, N. Y. state mus., 1916, p. 121, pl 30, fig. 9–12.

Undetermined hypostoma Raymond, Ann. Carnegie mus., 1910, **7**, pl. 19, fig. 22.

This species was described from fragments collected by Dr. Ruedemann. More recently the writer has found at the typical locality an incomplete cranidium which is somewhat larger and more perfect than the original. It shows that although the eye is large, the palpebral lobe is small, and that very strongly defined eye-lines are present.

Until this trilobite was discovered, *Ceraurus scutiger* (Eichwald) and *C. dentatus* Raymond and Barton were the species of the genus which had produced the largest specimens. Complete specimens of the latter, 84 mm. in length on the median line, have been found, and the length of *C. scutiger* is estimated at 106 mm. *Ceraurus ruedemanni*, however, if it had the same proportions as *C. dentatus*, must have reached a length on the median line of 160 mm., and at least 25 mm. should be added for the pygidial spines. Under the favorable conditions which existed among the reefs of Stromatocerium in the later parts of Chazy time, trilobites appear to have reached unusual size.

Measurements: — The cranidium figured is 46 mm. long, and 73 mm. wide at the palpebral lobes. The glabella is 37 mm. long, 38 mm. wide at the front, and 35 mm. at the basal lobes.

Horizon and Locality: — This species has so far been found only in the reef at the base of the Upper Chazy in a pasture, three miles east of Chazy, N. Y., and at the same horizon at Coopersville, N. Y.

Ceraurinus pompilius (Billings).

Cheirurus pompilius Billings, Pal. foss. Canada, 1865, **1**, p. 181, fig. 162.
Ceraurinus pompilius Barton, Bull. M. C. Z., 1913, **54**, p. 550. Washington univ. studies, 1916, **3**, pt. 1, no. 1, p. 134.

The original locality of this species cited by Billings was "South side of Large Island, Mingan Islands." Professor Twenhofel collected a single imperfect glabella of exactly the same size as the type in zone A_5 on Bald Island, Mingan. Since it has been shown that the specimens from Valcour Island, N. Y., which I identified as *C. pompilius* do not belong to it (Bull. M. C. Z., 1913, **54**, p. 536), this species is unknown outside the typical region.

Attention should be called to the date of publication of Dr. Barton's second paper, which, through no fault of the author, bears the date of July, 1915, although it was not actually published till 20 January, 1916, and not distributed, at least in the form of separata, for some weeks after that.

Ceraurinus polydorus (Billings).

Cheirurus polydorus Billings, Pal. foss. Canada, 1865, **1**, p. 286, fig. 274.
Ceraurinus polydorus Barton, Bull. M. C. Z., 1913, **54**, p. 549. Washington univ. studies, 1916, **3**, pt. 1, no. 1, p. 134.

One of the specimens from Newfoundland reveals the presence in this species of eye-lines, which originate a little in front of the middle of the first lateral glabellar lobes, and run backward to the palpebral lobes, which are opposite the second pair on the glabella. Otherwise the specimens add nothing to what was known from Billings's short description.

Horizon and Locality: — Billings's specimens were from division N, Table Head, and division P, Portland Creek. Professors Schuchert and Twenhofel collected it only from their zones N_1 and N_2 at Table Head, Nfld. Professor Hyatt collected a rather good cranidium from the conglomerates at Cow Head, Nfld.

Kawina vulcanus (Billings).

Cheirurus vulcanus Billings, Pal. foss. Canada, 1865, **1**, p. 284, fig. 271a–c (*non* p. 324, fig. 310a–c).
Pseudosphaerexochus vulcanus Raymond, Ann. Carnegie mus., 1905, **3**, p. 367, pl. 14, fig. 16, p. 368, fig. 10. 7th rept. Vermont state geol., 1910, p. 241, pl. 36, fig. 16. Grabau and Shimer, N. A. index fossils, 1910, **2**, p. 320, fig. 1634d.

Cheirurus prolificus Billings, Pal. foss. Canada, 1865, **1**, p. 325, fig. 311, 312.
Ceraurus (Pseudosphaerexochus) prolificus Clarke, Geol. Minn., 1897, **3**, pt. 2, p. 738.
Kawina vulcanus Barton, Washington univ. studies, 1916, **3**, pt. 1, no. 1, p. 117, fig. 9.

Professor Hyatt collected a glabella of this species at the typical locality, Cow Head, Nfld. Billings cited it under the names *Cheirurus vulcanus* and *C. prolificus* from Stanbridge, Que., and from the Upper Chazy at Montreal. Mrs. Eleanor M. Hudson later found a single incomplete cephalon, which I figured, in the lower part of the Upper Chazy on Valcour Island, N. Y. Professor Twenhofel collected a single small glabella in zone A_5, Upper Chazy, on Bald Island, Mingan Islands.

Professors Schuchert and Dunbar collected a large number of cranidia and cephala of *Cheirurus prolificus* and a smaller number which can be referred to *C. vulcanus* from the type-locality. After going over them rather carefully it appears probable that the specimens called *C. prolificus* are the young of *C. vulcanus*. The only difference noted by Billings was that in *C. vulcanus* the eye was opposite the anterior end of the last glabellar lobe, whereas in *C. prolificus* it was opposite the second lobes. As can be seen by inspecting Billings's figures there was only a very slight difference in position of the eyes of the types, and one would expect to find the eyes slightly farther forward in young than in adults. Moreover, I find there is a slight variation in the position of the eyes among specimens of *C. prolificus*, they being farther back in some than in others. The specimens called *C. prolificus* are generally smoother than the typical *C. vulcanus*, but that appearance is due in part to the state of preservation.

One small fragment shows the last four segments of the thorax. The axial lobe is wide, moderately convex. The pleural lobes are flat and not much deflected at the sides, but the ends of each segment curve backward in flat spines. Each pleural portion of a segment has a narrow impressed line running diagonally across it. A single small pygidium presents the same characteristics as the one figured by Billings, except that the posterior end of the axial lobe is more blunt.

Kawina sp.

Pliomera aff. *fischeri* (Eichwald). Reed, Quart. journ. Geol. soc. London, 1909, **65**, p. 144, pl. 6, fig. 4.

The presence of a Kawina closely related to *K. vulcanus* (Billings) in Ireland is indicated by the excellent figure published by Reed. As in

the Canadian species there are three pairs of broad blunt ribs, a wide V-shaped axial lobe with four rings and a triangular terminal piece. It seems, however, to be wider, and the surface, so far as one can judge from the description and figure, is smooth.

Horizon and Locality:— This species was found in a limestone breccia, one mile southwest of the Gortbunacullin farm, in the Tourmakeady district, County Mayo, Ireland.

Kawina trentonensis (Clarke).

Pseudosphaerexochus trentonensis Clarke, Geol. Minn., 1897, **3**, pt. 2, p. 734, fig. 53, 54. Weller, Geol. surv. New Jersey. Pal., 1903, **3**, p. 205, pl. 15, fig. 24, 25.

In the absence of any specimens retaining the free cheeks, Barton (Washington univ. studies, 1916, **3**, pt. 1, no. 1) was unable to place this species generically. The Walcott collection from Trenton Falls contains two cranidia which retain parts of the fixed cheeks, and, although neither is satisfactorily preserved, they show that the eyes were small, located close to the glabella opposite the second pair of lobes, and that the fixed cheeks were covered with pits surrounded by inosculating ridges dotted with small pustules. The cheeks slope abruptly downward from the highly vaulted glabella, and the posterior course of the facial suture is first outward, then slightly forward, turning backward in a broad arc to the genal angle.

The eyes are nearer the glabella, and the posterior branch of the facial suture reaches the posterior margin farther back than in Pseudosphaerexochus, so that the agreement with Kawina is much more complete.

Measurements:— A large glabella (*plus* the occipital ring) is 25 mm. long and 24.5 mm. wide at the base. A smaller one is 13 mm. long and 13 mm. wide at the base.

Horizon and Locality:— This species, the largest of the genus, is the sole one to survive so late as the Trenton. It has been found in the Trenton only at Trenton Falls, N. Y., but is also known from the Black River at Jacksonburg, N. J.

Nieszkowskia excelsus, sp. nov.

Plate **10**, fig. 8.

A large Nieszkowskia, with a very convex, highly vaulted cephalon. Glabella very convex, semioval in outline, with a long spine standing

erect on the highest point. There are three pairs of glabellar furrows, all narrow and shallow. The posterior pair are distinct, originating in the dorsal furrows opposite the posterior margin of the eye, and running back to the neck-furrow, thus producing a pair of large triangular basal lobes. The other two pairs are very faint, and extend only part way up the sides of the glabella.

The specimen retains the left free cheek and eye. The eye is situated in about the middle of the cheeks and is small, but prominent. The facial suture follows the usual course in Nieszkowskia, the posterior branch cutting the lateral margin some distance in front of the genal angle and only a little behind the eye; the anterior branch turns forward and reaches the anterior margin near the dorsal furrow. The cheeks are marked by a number of large pits and numerous small sharp pustules.

Thorax and pygidium unknown.

Measurements:— The single half cephalon preserved is 21 mm. long, and about 40 mm. wide.

The only other large Nieszkowskia which has been described in this country is *N. perforator* (Billings) from division N, Table Head, Nfld. That species is quite different from the present one, as the spine points forward and not upward. *N. glaucus* (Billings) and *N. satyrus* (Billings) from the "Quebec group" at Stanbridge, Que., have a spine on top of the glabella, but in both species the spine is situated farther back on the glabella, and is inclined backward instead of forward. No European species of Nieszkowskia appears to have a spine on top of the glabella.

Horizon and Locality:— The single specimen was found by Professors Schuchert and Twenhofel in their zone 10 at Port au Choix, Nfld., where it was associated with *Pliomerops barrandei*, *Bathyurellus validus*, and *Illaenus* (Normanskill age). Holotype in the Yale University Museum. Plastotype (M. C. Z. 1,757).

Nieszkowskia perforator (Billings).

Cheirurus perforator Billings, Pal. foss. Canada, 1865, **1**, p. 287, fig. 275.
Ceraurus (Nieszkowskia) perforator Clarke, Geol. Minn., 1897, **3**, pt. 2, p. 738.

A small and incomplete glabella which appears to belong to this species was found by Professors Schuchert and Twenhofel in their zone 11 at Point Rich, Nfld. Although much smaller than Billings's specimen from division N, the shape and ornamentation of the glabella and the position of the spine and glabellar furrows is the same. In zone

11 it is associated with *Pliomerops barrandei*, *Illaenus fraternus*, two other species of Illaenus, and Acidiphorus. It is thus a Normanskill species.

Nieszkowskia, sp. ind.

Plate 8, fig. 21.

A specimen of large size is indicated by a single pygidium which unfortunately is damaged on all margins. As nearly as can be made out, the outer pleural ribs ended in spines, whereas the inner pair of ribs were united with the central piece, and the posterior margin of this portion was smoothly curved. This would produce a type of pygidium very unusual in Nieszkowskia, but more nearly like it than any other genus of cheirurids.

The cranidia of several species of Nieszkowskia are known in America, but only one other pygidium, a small one described by me (Ann. Carnegie mus., 1910, **7**, p. 76, pl. 18, fig. 13, pl. 19, fig. 20) from the Chazy at Chazy, N. Y., has been found.

This large pygidium suggests such a form as *Nieszkowskia variolaris* (Linnarsson), illustrated so fully by Schmidt (Mem. Acad. imp. sci. St. Petersburg, 1881, ser. 7, **30**, pl. 9, fig. 6–8). That species was supposed by Schmidt to have two pairs of broad spines on the pygidium.

Measurements: — The pygidium is 15 mm. long, and in its present incomplete state, 21 mm. wide.

Horizon and Locality: — The single specimen (M. C. Z. 1,623) was found in the Holston of the Catawba Valley, north of Salem, Va.

Hadrohybus, gen. nov.

This genus is proposed for Cheirurinae with very tumid glabella and with the vestiges of glabellar furrows represented only by pits, this being the principal distinction from Nieszkowskia. Type: — *Hadrohybus dunbari*, sp. nov.

Hadrohybus dunbari, sp. nov.

Plate 9, fig. 5, 6.

This species is based on two rather incomplete cranidia, one about 30 mm., the other about 60 mm. long, and thus both of large size for members of the family. The glabella is extremely tumid with a somewhat compressed elevation near the front. A pair of shallow pits

opposite the posterior part of the palpebral lobes represent the only vestiges of glabellar furrows. The fixed cheeks are only partially exposed, but appear to have been about as large as those of a Nieszkowskia. The front of the glabella is surrounded by a moderately wide, convex rim, from which it is separated by a narrow furrow. The palpebral lobe is large, with a distinctly flattened rim and is situated about half way to the front. The eye must have been very large.

The surface of the fixed cheeks, palpebral lobes, and the rim about the glabella is marked by shallow irregular pits and small depressed pustules. The surface of the glabella appears to be nearly smooth, but under a hand lens shows numerous fine anastomosing lines which give the surface a scale-like appearance.

This form can only be compared with species of Nieszkowskia, from all of which it differs in the reduction of the glabellar furrows.

Measurements: — The smaller cranidium, the holotype, is about 30 mm. long and 38 mm. wide at the palpebral lobes. The highest point on the glabella is 17 mm. above the level of the tops of the eyes. The larger cranidium is about 60 mm. long, about 76 mm. wide at the palpebral lobes; and the highest point on the glabella is about 35 mm. above the level of the eyes. A palpebral lobe is 15 mm. long.

Horizon and Locality: — These fossils were collected by Prof. C. O. Dunbar from a pebble in the Cow Head conglomerate on Stearing Island, opposite Cow Head, Nfld. In the same pebble were specimens of *Eoharpes fragilis, Homotelus catactus,* Illaenus, sp. and *Pliomerops barrandei.* The age indicated is therefore Normanskill. Cotypes in the Yale University Museum.

Sphaerocoryphe major Ruedemann.

Sphaerocoryphe major Ruedemann, Bull. 49, N. Y. state mus., 1901, p. 67, pl. 4, fig. 13.

Since the finding of any of the species described by Ruedemann from the pebbles of Rysedorph Hill in regularly bedded rocks is always worth recording, I would note here the discovery of a single glabella of this species in the Upper Echinosphaerites zone at Strasburg, Va. The bulbous part of the glabella is 8.5 mm. in diameter and almost exactly spherical. Dr. Ruedemann did not give measurements of his specimen, but on the figure, the glabella is 10 mm. wide. The largest specimen of *S. robusta* Walcott in the M. C. Z. has the glabella 4 mm. in diameter.

Sphaerexochus parvus Billings.

Plate **10**, fig. 5.

Trilobite, genus undetermined Billings, Canad. nat. geol., 1859, **4**, p. 468, fig. 37.

Sphaerexochus parvus Billings, Geol. Canada, 1863, p. 133, fig. 66. Pal. foss. Canada, 1865, **1**, p. 180, fig. 161a, b. Raymond, Ann. Carnegie mus., 1905, **3**, p. 366, fig. 4, 5; p. 372, pl. 14, fig. 22. 7th rept. Vermont state geol., 1910, p. 246, pl. 36, fig. 22. Grabau and Shimer, N. A. index fossils, 1910, **2**, p. 321, fig. 1634e.

The original localities of this species cited by Billings are the Island of Montreal, and the south side of Large Island, Mingan Islands.

Specimens of the glabella are quite common in the top of the Holston northeast of Blacksburg, in the strata characterized by Agnostus. These glabellae are of the same size as those found in the north, and like them, the posterior furrows entirely encircle the basal lobes, whereas the two anterior pairs are faintly impressed. The anterior furrows are short, and almost straight, running directly upward and a little backward. The basal lobes are nearly circular in outline. The fixed cheek is perhaps a trifle shorter than on specimens from the Chazy of the Champlain Valley, and is deeply indented by the occipital furrow. The surface of the glabella is minutely tuberculated.

The pygidium of this species has not previously been known. I found two in the Holston at the Thomas farm, and one in the lower part of the Lenoir at Bluff City. It is a small, only slightly convex plate, each of the pleural lobes bearing three prominent convex ribs which end in short, blunt, separated points. The axial lobe has two narrow rings beside the anterior half-ring, and ends in a triangular median piece between the last pair of pleural ribs.

Measurements:— A cranidium from the Holston on the Thomas farm is 5 mm. long, about 7 mm. wide; and the glabella is 5 mm. wide. The pygidium figured, which is from the same locality, is 2 mm. long, and 3 mm. wide. A somewhat larger one from Bluff City is 2.5 mm. long, and 4 mm. wide.

Horizon and Locality:— The typical localities are in the Upper Chazy. In the Champlain Valley the species ranges throughout the Chazy. In Virginia it is common at the top of the Holston, three miles northeast of Blacksburg, and present, though rare, in the Liberty Hall at Lexington, and at the top of the reef in the Holston at the Hoge farm, Bland Co., Va. It is also common in the Lenoir east of Bluff City, Tenn.

Sphaerexochus discrepans, sp. nov.

Plate 10, fig. 3, 4.

Glabella highly convex, but when viewed from above, half oval instead of circular in outline. There are three pairs of glabellar furrows, the first two pairs very faint, the last ones deeply impressed. Both the first two pairs of furrows are straight, and the first furrows as long as the second ones. The last pair turn backward, but do not quite reach the occipital furrow, ending abruptly in deep depressions. On some specimens a shallow furrow connects this depression with the occipital furrow. The fixed cheeks are short and narrow, crossed by the deep occipital furrow. The surface is practically smooth, or faintly granulose.

Measurements:— An average cranidium in 7 mm. long, and 8.5 mm. wide; the glabella is 6.5 mm. wide. A large glabella is 9 mm. long; a small one, 5 mm.

This species differs from *Sphaerexochus parvus* principally in the failure of the posterior glabellar furrows to reach the neck-furrow. The surface is also smoother, and some though not all of the specimens are less nearly spherical.

Horizon and Locality:— This species is common in the Holston at the McNutt quarry near Sharon Springs, Bland Co., Va., and in the reef of the Holston on the Hoge farm in the same county. One specimen was found associated with *Sphaerexochus parvus* in the top of the Holston, three miles northeast of Blacksburg, Va. The cotypes (M. C. Z. 1,621, 1,622) are from the McNutt quarry.

Sphaerexochus romingeri Hall.

Plate 10, fig. 1, 2.

Sphaerexochus romingeri Hall, 20th rept. N. Y. state cab. nat. hist., 1868, p. 375, pl. 21, fig. 4–7. Bassler, Bull. 92, U. S. N. M., 1915, p. 1167.

No complete specimen of this species has previously been figured, nor has the hypostoma been before recognized. The Day collection contains two small entire specimens, one of them retaining the hypostoma in position. Weller reported an entire specimen from Madison, Ind., but did not figure it. If other complete specimens exist, they have not been mentioned in the literature.

Sphaerexochus is one of the most stereotyped of all fossils, showing

very little variation except in size. It is, therefore, not surprising that there should be little difference between *S. romingeri* and *S. mirus* Beyrich, which is a common fossil in the Silurian of Bohemia. In the latter species the anterior glabellar furrows are somewhat more pronounced, the posterior part of the facial suture cuts the margin a little farther from the axis, and the pygidium is more spinose than in the American form.

There is some indication that more than one species is included under *S. romingeri*. Many specimens have the basal glabellar lobes rudely quadrangular instead of subcircular, and there are differences in the free cheeks. Weller (Chicago acad. sci., Bull. 4, 1907, pl. 24, fig. 17, 18) has figured a cephalon which has the anterior ends of the free cheeks extending downward nearly perpendicularly to the plane of the base of the glabella. Most specimens show free cheeks which become pointed at the front, and so lack this square appearance.

Foerste (Bull. Denison univ., 1888, **3**, pl. 13, fig. 6) described and figured a cranidium from Cedarville, Ohio, which is slightly longer than wide, whereas, the usual specimen is wider than long. It also has a small tubercle on the occipital segment near the place where the facial suture terminates. This has not been found on other specimens.

The hypostoma of *S. romingeri*, as shown by the figure, is a short plate. The lateral margins converge backward, and the posterior one is gently convex in outline, lacking the small median notch present on the lip of *S. mirus*. It occupies a wide space under the front of the cephalon between the anterior ends of the free cheeks. At the anterior corner of each free cheek there is a tubercle on the rounded border. The preservation is not good enough to allow the course of the facial suture across the front to be followed, so that it cannot be determined whether or not an epistoma is present.

The hypostoma does not lie in the plane of the lower surface of the glabella, but is turned downward so that it is nearly in line with the margins of the free cheeks.

Horizon and Locality:— The two entire specimens are from the Racine dolomite at Wauwatosa, Wis., and the figured one is in the Day collection, (M. C. Z. 1,876).

Sphaerexochus desertus (Billings).

Harpides ? desertus Billings, Pal. foss. Canada, 1865, **1**, p. 333, fig. 321.

Harpides ? desertus was described by Billings from a small glabella found in the bed of the Pike River at the village of Bedford, Que.

Two small cranidia of what seem to be the same species were obtained by Schuchert and Twenhofel in Newfoundland. As seen partly imbedded in the matrix they look like glabellae of Cyphaspis, but on cleaning appear to be either Sphaerexochus or Kawina, and because of the narrow fixed cheeks, are referred to the former genus.

Cranidium small, subglobose, the glabella making up its greater portion. The fixed cheeks are small, situated chiefly back of the eye, triangular, deflected downward. The glabella is large, convex, abruptly incurved at the front, pustulose. There are three pairs of glabellar furrows, the first two pairs short and narrow, indenting the sides only, the posterior pair deeper, and setting off a pair of small basal lobes. The eyes are situated well forward, opposite the outer ends of the posterior glabellar furrows, and close to the dorsal furrows. There is a small median tubercle on the nuchal segment.

Measurements: — The larger cranidium is 5 mm. long; and the glabella is 3.25 mm. wide at the middle. Billings's glabella of *Harpides? desertus* was 5 lines (10 mm.) long, and 3 lines (6 mm.) wide at the neck-furrow.

This species differs from all others of the genus in its less spherical glabella and smaller and less circular basal lobes.

Horizon and Locality: — Schuchert and Twenhofel collected one cranidium in zone M_2, Table Head, and two, one of which was later destroyed, in the Isolated limestone, N_1, Table Head, Nfld. The type was found at Bedford, Que.

Pliomerops canadensis (Billings).

?Calymene multicosta Hall, Pal. N. Y. 1847, **1**, p. 228, pl. 60, fig. 31.

Amphion canadensis Billings, Canad. nat. geol., 1859, **4**, p. 381, fig. 12. Geol. Canada, 1863, p. 133, fig. 69. Pal. foss. Canada, 1865, **1**, p. 288, fig. 278. Raymond, Ann. Carnegie mus., 1905, **3**, p. 363, pl. 14, fig. 10–13.

Pliomera canadensis Grabau and Shimer, N. A. index fossils, 1910, **2**, p. 321, fig. 1634a–c.

Pliomerops canadensis Raymond, Amer. journ. sci., 1905, ser. 4, **19**, p. 378. Ann. Carnegie mus., 1910, **7**, p. 75, fig. 4 and 6, pl. 18, fig. 14. 7th rept. Vermont state geol., 1910, p. 238, pl. 36, fig. 10–13, pl. 38, fig. 14. Perkins, 8th rept. Vermont state geol., 1912, pl. 18, fig. 14.

Specimens of this species in the Lenoir appear to be identical in all important features with those found in the Chazy of the Champlain Valley. No good pygidia have been found, but the shape of the glabella, number, position, and direction of the glabellar furrows,

position of the eyes, form of the thoracic segments, and ornamentation, are all the same as in specimens from Lake Champlain. The best specimen found shows the cranidium and sixteen segments of the thorax. The glabella, including the neck-segment, is 11 mm. long and 14 mm. wide, and the whole length of the specimen as preserved is 49 mm., indicating a specimen somewhat smaller than the largest found farther north.

Horizon and Locality: — The original localities cited by Billings were the Mingan Islands and Montreal, at both of which localities the strata are of Upper Chazy age. Schuchert and Twenhofel found it in zone A_3 of their Mingan formation. Near the lower end of Lake Champlain the species is found all through the Chazy, but is most abundant at the base of the upper part. In the Lenoir it is fairly common about six miles southeast of Knoxville in the large area exposed in the anticline southeast of the Ross Republic quarry.

Pliomerops barrandei (Billings).

Amphion barrandei Billings, Pal. foss. Canada, 1865, **1**, p. 288, fig. 277a, b.
Pliomerops barrandei Raymond, Ann. Carnegie mus., 1910, **7**, p. 76, fig. 7.

This species has a greater vertical range than any other found in Newfoundland and is a common form at several horizons, and yet, strangely enough, has never before been found outside that island. Known to Billings from fragments only, practically complete specimens have since been collected, so that all parts are now known.

Entire specimen elongate oval, tapering gently from cephalon to pygidium.

Cephalon approximately semicircular, with rounded genal angles. Around the sides and front is a narrow convex rim, which in front of the glabella, has a single notch on the median line. The glabella is evenly convex, but not raised greatly above the cheeks. It expands somewhat toward the front, and the dorsal furrows are nearly straight. Three pairs of deep glabellar furrows are present, the first pair being elongate depressions set diagonally in the frontal lobe; the other two are lateral and open into the dorsal furrows. The first pair reach almost to the narrow furrow in front of the glabella, but do not open into it. The eyes are situated close to the dorsal furrows and well back on the cheeks, about their own length in front of the neck-furrow. The facial sutures meet the lateral margin well in front of the genal angles and the anterior margin outside the dorsal furrows. The

exfoliated specimens commonly found do not show the surface markings, but well-preserved specimens are covered with fine tubercles.

The hypostoma is shaped like that of Ceraurus, but has wide wings at the sides and an indistinct keel on the median line.

The thorax has fifteen segments. The axial lobe is convex, and one third the total width. The pleural lobes are flat on top, abruptly deflected at the sides. Each pleuron is nearly flat on the top, and has no furrow, but the central elevated portion has a very narrow anterior and posterior border at a lower level.

Pygidium rounded, the five pairs of ribs ending in spines. The axial lobe has five rings, the first three or four of which curve forward. It terminates in a shield-shaped boss which is pointed behind, and bears a deep semicircular furrow which is convex backward and bounds a low mound at the front of the shield. The pleural ribs of small specimens are rather slender, but in large ones they are broad and flat.

Measurements: — A small specimen from zone 11 is 51 mm. long. A cephalon and thorax from Gargamella Cove is 50 mm. long, and 35 mm. wide at the genal angles. The cephalon of this specimen is 16 mm. long, the glabella 11 mm. wide at the back and 11 mm. wide at the front, an enlargement of 1 mm. in 15 mm. A small pygidium from zone 11 is 10 mm. long, and 13.5 mm. wide. A large one from the same zone is 35 mm. long.

This species is nearly allied to *P. canadensis* of the Chazy and Lenoir but differs in having isolated anterior glabellar furrows, and the eyes closer to the glabella. The thorax has only fifteen instead of nineteen segments, and the shield at the posterior end of the axial lobe of the pygidium is larger and more differentiated.

Horizon and Locality: — Billings reported this species from horizons I, K, L, Point Rich; L, M, N, Table Head, and Bonne Bay; and P, Portland Creek, and Cow Head. Professors Schuchert and Twenhofel found it in zone 3100–4 at Port au Choix (2 specimens); zone 10 (3100–6) at Point Rich (4 specimens); (3100–7) Point Rich (2 specimens); zone 11 (3100–8), Point Rich (21 specimens); (3100–9, Point Rich (4 specimens); Leperditia bed (3100–14) Table Head (10 specimens); zone M_1 (3100–15) Table Head (6 specimens); zone M_2 (3100–16) Table Head (10 specimens); zone N_1 (3100–17) Table Head (10 specimens); and Isolated limestone (3100–18) (1 specimen).

It was not found in higher strata. Professor Hyatt collected specimens, now in the M. C. Z., from the western side of Gargamella Cove, Nfld. In a small collection from the Simpson formation in the Arbuckle Mts., Okla., sent me by Prof. L. E. Trout, formerly of

Norman, I find one glabella and one pygidium that must be referred to this species. The glabella shows the characteristic isolated frontal furrows and the pygidium has the typical shield at the end of the axial lobe. These two specimens are from the lower part of the Simpson, one half mile southeast of Crusher, in the cutting on the Gulf, Colorado, and Santa Fe Railroad.

Pliomerops sp.

Pliomera aff. *barrandei* Billings. Reed, Quart. journ. Geol. soc. London, 1910, **66**, p. 145, pl. 6, fig. 5.
Acidaspis (?) sp. Reed, Ibidem, p. 148, pl. 6, fig. 8.

The pygidium of a Pliomerops, which is certainly very like *P. barrandei*, has been figured by Reed from Ireland. The axial lobe shows five rings and a triangular terminal piece, and there are five pairs of somewhat divergent ribs, ending in free spines. Another less perfect specimen was figured as possibly a species of Acidaspis.

Horizon and Locality:— These specimens were from the Shangort beds, of the Tourmakeady district, County Mayo, and from the calcareous ash southwest of Garranagerra, Glensaul district, County Galway, Ireland.

Pliomerops julius (Billings).

Amphion julius Billings, Pal. foss. Canada, 1865, **1**, p. 290, fig. 279.

This species has previously been known from the pygidium only. Although no entire specimens are yet at hand, cephala and pygidia with portions of the thorax attached permit the description of all parts.

Cephalon short, wide, strongly elevated, highest near the posterior margin. Glabella ovate, widest at the second pair of lobes, and tapering backward to the neck-ring. The dorsal furrows are deep at the sides, but narrow and shallow in front of the glabella. There are three pairs of short glabellar furrows, the first of which are directed slightly backward. The posterior lobes are very narrow. The cheeks are convex, with an elevated border separated from the mound-like inner portion by a deep furrow. The genal angles are obtusely rounded, and an isolated cheek strongly suggests an hypostoma. The eyes are small, situated well forward and close to the glabella. The posterior portion of the facial suture turns first outward into the marginal furrow, and then backward to the genal angle. The surface of the cheeks is covered with small pits. That of the remainder of the head appears to be smooth.

The thorax consists of at least fourteen segments, possibly more. The axial lobe is narrow and elevated, the pleural lobes flat on top, abruptly deflected at the sides. The pleural part of each segment bears a high narrow median ridge, and both it and the axial ring are conspicuously tuberculate.

The pygidium is convex, with a prominent axial lobe bearing nine or ten rings. The pleural lobes have five pairs of elevated ribs which end in somewhat divergent spines. The surface is covered with small tubercles.

This species is, as Billings noted, remarkable for the great number of rings on the axial lobe of the pygidium.

Measurements:— A cephalon and fourteen thoracic segments are together 22 mm. long; the cephalon is 7 mm. long, and 15 mm. wide; the glabella is 7 mm. wide at the second lobes. The axial lobe of the thorax is 5 mm. wide at the seventh segment, where the total width is about 15 mm.

Horizon and Locality:— The original specimens were from the conglomerates of division P at Cow Head, Nfld., and those collected by Schuchert and Dunbar are from the same locality.

Pliomerops bilirata, sp. nov.

Plate **10**, fig. 6, 7.

Cranidium small, short, wide, and highly convex. Glabella about one third the total width, as wide as long, depressed convex. There are only two pairs of glabellar furrows, which are short, straight, deep indentations in the sides of the glabella, so placed that the lateral lobes are subequal, although the hindmost ones are smallest. The eyes are small and high, situated opposite the second glabellar lobes and third furrows and close to the dorsal furrows. The cheeks are wide, with an unusually wide elevated border on the free cheeks. In front of the glabella this border becomes nearly vertical, so that little of it is seen from above. The genal angles are rounded.

The anterior portion of the facial suture extends from the eye downward and forward parallel to the dorsal furrow nearly to the front, then turns diagonally inward and crosses the furrow and margin, reaching the lower edge of the margin close to the median line. Back of the eye the suture extends out parallel to the nuchal furrow until it reaches the depression which separates the main portion of the cheek from the border, then turns diagonally backward, and meets the outer margin but slightly in front of the angle.

The surface is so completely exfoliated that no markings can be detected. The cheeks were probably not deeply pitted, or depressions would be present on the cast.

Measurements:— The most complete cephalon (the holotype) is 5.5 mm. long, and 11 mm. wide. The glabella is 5 mm. long, including the neck-ring, and 4 mm. wide at the frontal lobe. The width at the palpebral lobes is 8 mm.

The absence of the anterior pair of glabellar furrows is so striking a feature that detailed comparison with other species is unnecessary. The eyes are also higher, farther back, and closer to the glabella than is usual in this genus.

Horizon and Locality:— A rare fossil in a boulder in the conglomerate on lot 22, concession VI, two miles north of Mystic, Que., where it is associated with Normanskill fossils. Holotype (M. C. Z. 1,758).

Pliomerops nevadensis (Walcott).

Plate **10**, fig. 15.

Amphion nevadensis Walcott, Monogr. **8**, U. S. geol. surv., 1884, p. 94, pl. 12, fig. 13.

This species was described originally from the Upper Pogonip limestone of the White Pine district in Nevada, but Ulrich has identified it also in the Lower Simpson of the Arbuckle Mts., Okla. Dr. Walcott described only the cranidium, but pygidia, which because of their large size, are referred to this species, seem to be quite common in Oklahoma. The present description is derived from two incomplete cranidia and five more or less imperfect pygidia.

Entire specimens of large size for a Pliomerops. Glabella almost rectangular, longer than wide, expanding only very slightly toward the front. There are three pairs of glabellar furrows, those on the same side all parallel, and so long that their proximal ends almost meet. The posterior furrows open into the dorsal furrows, but the anterior ones do not quite reach the furrows, but if continued would bisect the anterior lateral angles of the glabella. The eyes are distant both from the posterior margin and the dorsal furrows and situated at the horizon of the outer ends of the second glabellar furrows. The surface of the glabella is covered with small rounded pustules while the cheeks are covered with large pits.

The pygidium is similar to that of other species of Pliomerops with five pairs of broad pleural ribs which end in spines, while on the axial

lobe are five ribs and behind it a long shield-shaped piece which projects far back between the last pair of pleural ribs. On the anterior portion of this shield there is a pair of slightly curved furrows parallel to the sides, which do not connect with each other.

Measurements: — A cranidium is about 31 mm. long, and was probably about 60 mm. wide when complete. The palpebral lobe is 10 mm. in front of the neck-furrow and 9 mm. from the dorsal furrow. The largest pygidium was about 32 mm. long, and 60 mm. wide when complete.

Horizon and Locality: — The specimens here described were collected by Prof. L. E. Trout from the Lower Simpson, Fall Creek and Cool Creek, and along the Gulf, Colorado and Santa Fe Railroad, in the Arbuckle Mts., Okla. The cranidium figured is M. C. Z. 1,642.

Pliomerops trouti, sp. nov.

Plate 10, fig. 14.

A third species of Pliomerops in the Simpson is represented by an imperfect cranidium. The cephalon is nearly semielliptical in outline, evenly convex, with a narrow convex border. Glabella but little longer than wide, expanding toward the front, depressed convex. All three pairs of glabellar furrows are long and deeply impressed and all enter the dorsal furrows, the anterior ones just behind the anterior angles of the glabella. The frontal and glabellar lobes are all narrow, and the furrows all curve somewhat backward. The eyes are situated far forward, close to the anterior margin, and far from the dorsal and nuchal furrows. The cheeks are covered with pits and pustules, and the glabella with low pustules.

Measurements: — The cephalon when complete was about 13.5 mm. long, and about 36 mm. wide. The glabella was about 12 mm. long, and 12 mm. wide at the front.

This species is more nearly allied to *Pliomerops canadensis* than to any other species, but differs in the position and great length of the anterior glabellar furrows. It has a much shorter glabella than *P. nevadensis*, and the anterior furrows are not isolated as in *P. barrandei* and *P. nevadensis*.

Horizon and Locality: — The holotype (M. C. Z. 1,662) was collected by Prof. L. E. Trout in the Lower Simpson, Arbuckle Mts., Okla., one half mile southeast of Crusher, in a cutting of the Gulf, Colorado, and Santa Fe Railroad.

Perischoclonus, gen. nov.

This generic name is proposed for a small trilobite which is referred with considerable doubt to the Cheiruridae, but which may belong in the Opisthoparia. With such confusion existing, it is not possible to give a complete generic diagnosis, but the chief characteristics are the long glabella which expands toward the front, three pairs of glabellar furrows developed as pits, and eyes rather distant from the glabella and far back. Type: — *Perischoclonus capitalis*, sp. nov.

The uncertainty as to the systematic position of this species arises from the fact that on the only specimen the course of the posterior portion of the facial suture is obscured, apparently by fusion, for the shell is well preserved. There are two or three lines which might be taken for the suture, and the most prominent of these seems to cut the genal angle or just within it. Trilobites with small eyes and long expanding furrowed glabella are not common, hence the comparison of this cephalon to that of some species of the Cheiruridae. Among the Opisthoparia only a few of the species of Karlia and Corynexochus of the Middle Cambrian seem to possess the same combination of characteristics.

Perischoclonus capitalis, sp. nov.

Plate **10**, fig. 13.

Cephalon nearly semicircular in outline, moderately convex, with long prominent glabella. The dorsal furrows are narrow, deep, with a V-shaped section, and converge backward to the horizon of the eyes, then diverge slightly to the neck-furrow. There are three pairs of glabellar furrows, represented by pits close to the dorsal furrow. The posterior pair are bifurcated, Y-shaped, one arm of the Y extending forward and one backward, the short stem connecting laterally with the dorsal furrow. The fixed cheeks are wide, higher than the free cheeks, and the eyes are situated just outside the highest point, on the lateral slopes. The free cheeks descend steeply to the narrow flattened border. This border is widest at the anterior ends of the dorsal furrows, and very narrow in front of the glabella.

From the eye the facial suture pursues a nearly straight course across the cheek to the depressed border, where it curves slightly inward, reaching the margin in front of the dorsal furrow. As stated above, the course back of the eye is unknown.

The surface of both glabella and cheeks is covered by very small

pustules which are somewhat more pointed on the glabella than on the cheeks.

I do not know any other trilobite which is liable to be confused with this one.

Measurements: — Length of cephalon, 5.5 mm., width 9 mm.

Horizon and Locality: — The type was collected from a pebble in the Cow Head conglomerate at Lower Head, Nfld. In the same fragment of rock is a shield of *Arthrorhachis galba*, indicating the Normanskill age. The holotype is in the Yale University Museum.

Phacopidae Corda.

Pterygometopus annulatus Raymond.

Plate **10**, fig. 16, 17.

Pterygometopus annulatus Raymond, Ann. Carnegie mus., 1905, **3**, p. 376, pl. 14, fig. 24, 25. 7th rept. Vermont state geol., 1910, p. 247, pl. 36, fig. 24, 25.

A Pterygometopus which I cannot at present distinguish from *P. annulatus* occurs in various places in the Holston, Ottosee, and Athens. The cephalon differs so slightly from that of *P. callicephalus* Hall of the Trenton that specimens can only be separated by direct comparison. The anterior glabellar lobes are somewhat longer in the specimens from the Normanskill than in those from the Trenton and the second pair somewhat smaller. The pygidium, like that of *P. annulatus*, is somewhat variable, and shows this variation most in the point at which the ribs on the pleural lobes bifurcate. In some specimens they divide very close to the dorsal furrows, as in *P. callicephalus*, whereas in others they do not bifurcate until they reach the slope of the lobe.

No entire specimens have been seen, the largest piece being a pygidium with eight thoracic segments attached.

Measurements:— A pygidium and eight thoracic segments are together 28 mm. long, and 20 mm. wide at the anterior end. The axial lobe at the front is 8 mm wide. The pygidium is 13 mm. long, and about 17 mm. wide at the anterior end. An unusually large cephalon is 20 mm. long, and 25 mm. wide. The eyes are 6 mm. long, the frontal lobe is 7 mm. long, and 18.5 mm. wide.

Horizon and Locality:— The original locality for this species was Valcour Island, N. Y., where it ranges throughout the Chazy. It is present, though not common, in the chert of the lowest part of the Holston on New River, Va., two miles east of Goodwins Ferry, and 1

have one specimen from the same horizon in the Catawba Valley. It is fairly common in the Liberty Hall near the reservoir at Lexington, Va., is extremely abundant in the thinly bedded limestone of the middle part of the Athens in the railroad cutting one mile south of Otes, Tenn., and is found in the Athens at Chatham Hill, north of Marion, Va. On the hills east of the quarries at Saltville, Va., it is quite common in beds which have been called Ottosee, and Dr. Shuler collected many specimens farther north on Walker Mt., at Tilsons Gap, Va. The figured specimens (M. C. Z. 1,665–1667) were found in material brought from the cutting near Otes, Tenn.

Pterygometopus holstonensis, sp. nov.

Plate 10, fig. 9–11.

This species is known only from imperfect cephala and pygidia, but is readily recognized by its distinctive glabella.

Cephalon rather evenly vaulted, relatively smooth for the genus. Glabella depressed convex, uniformly curved, covered with small tubercles. All glabellar furrows are narrow, distinct, but not deeply impressed. The anterior ones are not straight as in most species of the genus but doubly curved, becoming straight toward their proximal ends. The second furrows are short and do not unite with the dorsal furrows, so that the two principal lateral lobes on each side are confluent. The basal lobes are small. The eyes and free cheeks are not well shown on any of the specimens, but seem to be of normal size.

The pygidium associated with these cephala is rather short for a Pterygometopus, highly vaulted with a prominent axial lobe. The axial lobe has about eight distinct rings which cross it directly and the pleural lobes show seven pairs of ribs, which do not bifurcate in most cases though some specimens do show a weakly impressed line along the middle of each rib.

Measurements:— The largest cephalon is 14 mm. long, and about 20 mm. wide. The glabella is 12.5 mm. wide at the front; and the eye approximately 6 mm. long. The largest pygidium is 8 mm. long, and 11 mm. wide. The axial lobe is 4 mm. wide at the front.

I do not know any other American species of Pterygometopus which has doubly curved anterior glabellar furrows like this one, and only *P. eboraceus* Clarke shows a tendency toward fusion of the glabellar lobes. The fragmentary specimen described by Ruedemann as *P. eboraceus* from Rysedorph Hill (Bull. 49, N. Y. state mus., 1902,

p. 69, pl. 4, fig. 15) is much like *P. holstonensis*, but the anterior furrows do not have the double curvature.

Among the European species I have seen nothing closely comparable, unless it be *P. brongniarti* Portlock. Some of the specimens figured by Salter (Palaeontogr. soc., 1864 (1866), p. 34, pl. 1, fig. 20a) as belonging to this species have somewhat doubly curved anterior furrows and confluent lateral lobes.

Horizon and Locality:— This species has so far been found only in the Holston limestone on the Hoge farm, Bland County, Va. The cotypes are M. C. Z. 1,644–1,646.

Pterygometopus gracilens, sp. nov.

Plate **10**, fig. 18.

The head is represented by the median portion of the cranidium only. This is a miniature of *P. annulatus*, and needs no especial description. All the glabellar furrows connect with the dorsal ones, the glabella contracts rapidly to the nuchal segment, and the surface is covered with small granules.

The pygidium is triangular, the sides nearly straight, and is so high that it appears narrower than it really is. The axial lobe is narrow, and extends nearly, but not quite to the posterior end. It bears eight defined rings, and is obscurely segmented to the posterior end.

The pleural lobes are steep slopes, each with eight flat, furrowed ribs. The median groove on each rib extends obscurely to the dorsal furrow. Surface minutely granulose.

Measurements:— A cranidium is 4.75 mm. long; the width of the frontal lobe of the glabella being 4.00 mm.; the width at the palpebral lobes 5.25 mm., and at the nuchal segment 1.90 mm.

A pygidium, the holotype, is 4.5 mm. long, and about 4.5 mm. wide; the axial lobe is 2.00 mm. wide at the front, and 3.75 mm. long.

The head is, so far as the imperfect specimens show, of the same type as *Pterygometopus callicephalus* Hall and *P. annulatus* Raymond, being distinguishable only by its small size. The pygidium is, however, much more triangular than that of either of those species, and has the same outline as *P. intermedius* Walcott (Clarke, Pal. Minn., 1897, **3**, pl. 2, p. 727, fig. 47).

It differs from the latter in having a somewhat shorter axial lobe, and in having all the ribs of the pleural lobes furrowed.

Horizon and Locality:— This species is very common in the lower part of the Lenoir, one mile east of Bluff City, Tenn. Holotype (M. C. Z. 1,725).

Pterygometopus transsectus, sp. nov.

Plate **10**, fig. 12.

This species may be described briefly by stating its differences from other species of the genus. From nearly all American species it differs in having a practically smooth surface, the tubercles being very low and inconspicuous. The first of the side lobes is also unusually small and narrow, and the second side lobe is pointed on the distal end. The basal lobes which in most species are small, are relatively large and mound-like, and situated farther from the median line than is usual.

Were these characteristics less distinctive I should hesitate to describe a species on the little material so far found, but as there seems to be no other described smooth Pterygometopus with glabellar lobes like this, there will be no difficulty in its recognition.

Measurements:— Length of cephalon, about 4.5 mm., width 9 mm.

Horizon and Locality:— A very rare fossil in the coarsely crystalline strata at the top of the Holston, three miles northeast of Blacksburg, Va. Holotype (M. C. Z. 1,641).

FAUNAL ASSOCIATIONS.

The Trilobites of the Ordovician of Newfoundland.

The greater part of the collection from Newfoundland which was studied in the preparation of this paper was made by Professors Schuchert, Twenhofel, and Dunbar, and it is not the province of the writer to discuss the stratigraphy or complete faunal associations. This will be done by Professors Schuchert and Dunbar. For the present, the stratigraphy as outlined in the Geology of Canada, 1863, will form the basis for the order of succession.

Three rather distinct faunal associations will be observed. The first and oldest is a small one, found in divisions F, G, and H of Logan's section.

Trilobites of Divisions F, G, H.

Petigurus nero (Billings), *P. timon* (Billings), *Bathyurellus abruptus* Billings, *B. marginatus* Billings, *Isoteloides whitfieldi* Raymond.

Billings listed from the same zones the following, in addition to the above:—

Hystricurus cordai (Billings), *Goniurus caudatus* (Billings), "*Dolichometopus*" *convexus* Billings, "*D.*" *gibberulus* Billings, *Pliomerops? insularis* (Billings).

The recent study has added nothing to this fauna, which, as pointed out by Billings, is of Beekmantown age.

Petigurus nero and *P. timon* have not been found outside of western Newfoundland, but the former is very similar to *P. cybele*, which occurs in the Beekmantown on the Mingan Islands. *Bathyurellus abruptus* also has no value in correlation, but *B. marginatus* is quite similar to a species found in division B of the Beekmantown at Philipsburg. *Isoteloides whitfieldi* is a common member of the Fort Cassin fauna, but probably has a considerable vertical range.

Hystricurus cordai is known from division B at Philipsburg, Que., and from the upper part of the Beekmantown at Beekmantown, N. Y., and *Goniurus caudatus* is a typical Fort Cassin fossil. The two species referred to Dolichometopus are very like the third species *D. rarus*, described by Billings from the Beekmantown at Oxford, Ont. It is there associated with *Pliomerops salteri*, which may be a relative of the little known *P. ? insularis* of Newfoundland.

On the whole, the trilobites here listed would indicate a middle or upper Beekmantown age for the strata from which they were obtained. There is no trace of any member of the Ceratopyge fauna, or of any European element.

Trilobites of Divisions I, K, L.

Bathyurellus validus Billings (also in N), *Illaenus consimilis* Billings (also in M and N), *I. fraternus* Billings (also in N), *I. marginalis* Raymond (also in M), *I. alveatus* Raymond, *Ectenonotus westoni* (Billings), *Nieszkowskia perforator* (Billings), *N. excelsa* Raymond, *Pliomerops barrandei* (Billings) (also in M and N), *Acidiphorus spinifer* Raymond (also in M).

Billings records *Asaphus canalis* Conrad from these divisions, but in the absence of material, I cannot determine what species is so designated.

Most of the trilobites listed above have not been found below division L, and, as indicated, six of them occur in divisions M or N or both. None occurs in any division below I.

This fauna has no exact counterpart in America, but its affinities are with that of the Chazy.

Bathyurellus validus is unlike the two species of that genus in the Beekmantown, but allied to *B. minor* Raymond, of the Middle Chazy of Crown Point and Valcour Island, N. Y.

Illaenus is a rare genus in the typical Chazy, but *I. bayfieldi* is common in the Mingan Islands. Nieszkowskia occurs in the Upper Chazy on Valcour Island, and *Pliomerops canadensis* of the Middle and Upper Chazy is allied to *P. barrandei*. *Ectenonotus westoni* has previously been found only in boulders.

The general similarity of this fauna to that of the Chazy, coupled with the fact that six of the species range upward into higher beds, which contain a fauna about which there can be no doubt, indicates a post-Beekmantown, and probably early or middle Chazyan age for these divisions.

Trilobites of Division M.

Arthrorhachis galba (Billings) (also in N), *A. longicollis* Raymond, *Harpides concentricus* Billings, *Raphiophorus semicostatus* (Billings) (also in N), *Lonchodomas normalis* (Billings) (also in N), *Remopleurides panderi* Billings (also in N), *Bronteopsis gregaria* Raymond (also in N), *Niobe quadraticaudata* (Billings) (also in N), *Illaenus consimilis* Billings (also in L and N), *I. marginalis* Raymond (also in L), *Sphaerexochus desertus* Billings (also in N), *Pliomerops barrandei* (Billings) (also in L and N), *Acidiphorus spinifer* Raymond (also in L).

Trilobites of Division N.

Arthrorhachis galba (Billings) (also in M), *Raphiophorus semicostatus* (Billings) (also in M), *Ampyx laeviusculus* Billings, *Lonchodomas normalis* (Billings) (also in M), *Endymionia schucherti* Raymond, *Anisonotus glacialis* (Billings), *Triarthrus fischeri* Billings, *Remopleurides panderi* Billings (also in M), *Robergia schlotheimi* (Billings), *Telephus americanus* Billings, *Bronteopsis scotica* Nicholson and Etheridge, *B. gregaria* Raymond (also in M), *Bathyurellus validus* Billings (also in L), *Niobe quadraticaudata* (Billings) (also in M), *N. morrisi* (Billings), *N. lineolata* Raymond, *Nileus macrops* Billings, *N. scrutator* Billings, *Megalaspis huttoni* (Billings), *Illaenus consimilis*

Billings (also in L and M), *I. fraternus* Billings (also in L), *Cybele mira* (Billings), *Ceraurinus polydorus* (Billings), *Sphaerexochus desertus* (Billings) (also in M), *Pliomerops barrandei* (Billings) (also in L and M).

Billings listed from this division two more species:—

Petigurus nero (Billings), *Heliomera sol* (Billings).

These two lists show that the two divisions have many trilobites in common, and the same general type of fauna characterizes both. Lithologically, the strata become increasingly dark, carbonaceous, and thinly bedded upward, and there is a corresponding change in fauna, as will be brought out by Schuchert and Dunbar.

Taken as a whole, this is a rather remarkable fauna, and one more at home in northern Europe than America. Lonchodomas, Remopleurides, Bathyurellus, Illaenus, Ceraurinus, Pliomerops, Sphaerexochus, and Heliomera occur in the Chazy, and one of the species, *Heliomera sol*, has been found at Chazy, N. Y., in the upper part of the Lower Chazy.

Arthrorhachis galba, Remopleurides panderi, Bronteopsis gregaria, Robergia schlotheimi, Nileus scrutator, and *Pliomerops barrandei* are shown in this paper to be present elsewhere in America in strata which are younger than the Beekmantown and older than the Trenton. Endymionia is represented by another species in the Levis shales, and Remopleurides, Triarthrus, Illaenus, and Cybele are represented in Trenton or post-Trenton formations.

Trilobites of the Cow Head Conglomerate.

Arthrorhachis galba (Billings), *Eoharpes granti* (Billings), *E. fragilis* Raymond, *Ischyrotoma twenhofeli* Raymond, *Bathyurellus nitidus* Billings, *B. formosus* Billings, *B. fraternus* Billings, *B. expansus* Billings, *Homotelus catactus* Raymond, *Illaenus tumidifrons* Billings, *I. consobrinus* Billings, *Amphilichas jukesi* (Billings), *Kawina vulcanus* (Billings), *Hadrohybus dunbari* Raymond, *Pliomerops barrandei* (Billings), *P. julius* (Billings), *Perischoclonus capitalis* Raymond.

The species listed above were obtained by Professors Schuchert, Twenhofel, and Dunbar from the Cow Head conglomerate at Cow Head and on Stearing Island, Nfld. It will be noted that only two of the species, *Arthrorhachis galba* and *Pliomerops barrandei*, appear on the preceding lists. The former of these occurs *in situ* in zones M and N, the latter in zones L, M, and N. *Eoharpes granti* (Billings) and *Bathyurellus expansus* Billings have been found previously only on

lot 20, range 6 of Stanbridge, in boulders, and *Kawina vulcanus* has been found at the base of the Upper Chazy on Valcour Island, N. Y. Hyatt found a specimen of *Bathyurellus fraternus* at Gargamella Cove, Nfld., where it was associated with trilobites characteristic of zones M and N. *Eoharpes fragilis, Pliomerops barrandei, Homotelus catactus,* and *Hadrohybus dunbari* were found in one boulder on Stearing Island, and *Arthrorhachis galba* and *Perischoclonus capitalis* in another at Lower Head.

Ten of the sixteen species are therefore more or less definitely associated with zones M or N or the Upper Chazy, and it seems probable that all are of about this age. Most of the specimens were obtained from a light-colored limestone, quite unlike that of zones M and N, and the situation reminds one very much of the relationship of the Holston of Virginia and Tennessee to the Athens.

Comparison of the faunas in Newfoundland with those of other regions.

The Glensaul District.

A fauna which in some respects is strikingly like that of M and N is the one described by Reed from the Glensaul District, County Galway, Ireland. The following trilobites were found at one or another of six localities within an area of less than a square mile (Gardiner and Reynolds, Quart. jour. Geol. soc. London, 1910, **66**, p. 265).

Bathyurellus glensaulensis Reed, *Bathyurellus* sp., *Bathyurus aff. nero* Billings, *B. cf. timon* Billings, *Bronteopsis* sp., *Calymene* sp., *Cheirurus cf. clavifrons* Dalman, *C. aff. ornatus* Dalman, *Pseudosphaerexochus* sp., *Cybele* sp., *Encrinurus octocostatus* Reed, *cf. Ectenonotus westoni* (Billings), *Harpes* sp., *Illaenus weaveri* Reed, allied to *I. alveatus* Raymond, *Illaenus* sp., *Megalaspis* (?) sp., *Nileus armadillo* Dalman, *cf. N. scrutator* Billings, *Niobe* sp., compared with *N. morrisi* (Billings), *Chasmops aff. odini* Eichwald, *Pliomerops aff. barrandei* Billings, *Pliomera pseudoarticulata* Portlock, allied *Ectenonotus westoni* (Billings), *Remopleurides* sp., *Sphaerocoryphe* sp., *Telephus hibernicus* Reed, allied to *T. americanus* Billings.

This is the only extra-American locality at which Bathyurellus has been found, and the species is of the *B. validus* type, not that of the Beekmantown. The forms referred to Bathyurus are somewhat of a puzzle at present. It will be noted that Billings reported "*Bathyurus*" *nero* from Division N. Schuchert and Twenhofel collected from that horizon fragments of a trilobite which is probably *Ischyrotoma twenhofeli,* and that may be the species noted by Billings. The presence of

Bronteopsis, Cybele, Nileus, *Pliomerops aff. barrandei*, and Remopleurides in the Irish fauna, even though not specifically identified, give the fauna an aspect very like that in Newfoundland. As I have shown (p. 110) *Illaenus weaveri* is very closely allied to *I. alveatus*, and *Pliomera pseudoarticulata*, and *Encrinurus octocostatus* probably represent one species of Ectenonotus allied to *E. westoni*.

Reed, with some hesitation, placed this fauna in the Arenig, probably because all the graptolites in the region were of that age. The graptolites and trilobites were not, however, associated, or even in the same formations. In view of the close similarity of this fauna to that in western Newfoundland, it seems more probable that the original reference to the Llandeilo was correct.

Girvan District, Scotland.

Reed (Palaeontogr. Society, for 1903, 1904, 1906, 1914) has described the Ordovician trilobites of the Girvan District, Ayrshire. In the somewhat unusual faunas of that region, agnostids, ampycids, Bronteopsis, Telephus, Remopleurides and other trilobites similar to those found in western Newfoundland were obtained from more than one horizon. The greatest similarity, however, appears when the fauna under discussion is compared with that of the Balclatchie Group.

The Balclatchie Group has yielded fifty-one species of trilobites, only a part of them being allied to those found in Newfoundland. The comparable species of the two regions are listed in parallel columns: —

Girvan.	*Newfoundland.*
Arthrorhachis girvanensis (Reed),	*A. galba* (Billings).
Anisonotus hornei (Nicholson and Etheridge),	*A. glacialis* (Billings).
Lonchodomas macallumi (Salter),	*L. normalis* (Billings).
Triarthrus reedi Raymond,	*T. fischeri* Billings.
Robergia barrandei (Nicholson and Etheridge),	*R. schlotheimi* (Billings).
Remopleurides girvanensis Reed,	*R. panderi* Billings.
Telephus salteri Reed,	*T. americanus* Billings.
Illaenus balclatchiensis Reed,	*I. fraternus* Billings.
I. latus M'Coy,	*I. consimilis* Billings.
Bronteopsis scotica Nicholson and Etheridge,	*B. scotica* Nicholson and Etheridge.
B. ardmillanensis Reed,	*B. gregaria* Raymond.
Cybele michelli Reed,	*Cybele mira* (Billings).

Twelve of the thirty-one species of trilobites found in divisions M and N are closely allied to species found in the Balclatchie Group, and the similarity of the two faunas is emphasized by the occurrence in each of Anisonotus, a genus unknown outside these formations, and *Bronteopsis scotica*, a species also confined to them.

Jemtland, Sweden.

Hadding (Meddel. Lunds geol. fältklubb, 1913, ser. B, no. 6, p. 22 et seq.) has described the fauna of the Lower Dicellograptus beds (Ogygiocarisskiffern) at Anderson in Jemtland. These beds are divided into two zones, those characterized by *Climacograptus putillus* below, followed by strata with *Nemagraptus gracilis*. The variety of trilobites is not great, but includes such significant species as *Triarthrus humilis* Hadding, *Megalaspis patagiata* Tornquist, *Nileus armadillo* Dalman, *Ceraurus exsul* (Beyrich), *Ampyx clavifrons* Hadding, *A. costatus* Boeck, *Telephus bicuspis* Angelin, *T. mobergi* Hadding, *T. granulatus* Angelin, *Remopleurides circularis* Hadding, *R. subquadratus* Hadding, and *Robergia micropthalma* Linnarsson, besides six species not yet known to be represented by related forms in Newfoundland.

Scania, Sweden.

Funkquist (Meddel. Lunds geol. fältklubb, 1919, ser. B, no. 11) has studied the shales between the Orthoceras limestone and the zone of *Dicranograptus elingani* in southeastern Scania, and shown that they represent the upper part of the Lower Dicellograptus zone, and the lower part of the Middle Dicellograptus zone of western Scania. There are but few trilobites, only nine specifically identified, in the zone next above the Orthoceras limestone, but seven of these are important for our correlation. They are *Lonchodomas rostratus* (Sars), *Nileus cornutus* Moberg, *N. superestes* (Olin), *Bronteopsis concentrica* (Linnarsson) (a form very close to *B. scotica*), *Remopleurides subquadratus* Hadding, *Telephus granulatus* Angelin, and *Trinucleus coscinorrhinus* Angelin. Some of these species are found at somewhat higher horizons, as high as the Middle Dicellograptus beds, but the majority of them are restricted to the *Trinucleus coscinorrhinus* zone.

Conglomerate at Mystic, Que.

Billings described a number of fossils from the township of Stanbridge, Que. These were in all cases derived from boulders in

limestone conglomerates, which have a great development in that region. One of the best exposures is located on lot 22, concession VI of Stanbridge, about two miles north of Mystic. A long list of species from this locality, as determined by Dr. H. M. Ami, was published by Ells (Geol. surv. Canada. Ann. rept., 1896, n.s., **7**, pt. J, p. 127).

Boulders of both Beekmantown and Normanskill age are found in this conglomerate, with the result, the fossils from these not having been kept separate, that considerable confusion has existed as to the composition of this fauna. The following trilobites were collected at this locality from a single boulder by Professor Schuchert and the writer: —

Arthrorhachis galba (Billings), *Remopleurides affinis* Billings, *Bathyurellus expansus* Billings, *Nileus scrutator* Billings, *N. macrops* Billings, *Bronteopsis marginata* Raymond, *Telephus* sp. ind., *Illaenus incertus* Billings, *I. simulator* Billings, *Acidiphorus scorpionis* Raymond, "*Bathyurus*" *breviceps* Billings, *Ectenonotus westoni* (Billings), *Kawina vulcanus* (Billings), *Pliomerops biliratus* Raymond.

Another boulder contained: —

Arthrorhachis galba (Billings), *Robergia breviceps* Raymond, *Homotelus pelops* (Billings).

This fauna is of some interest, since it is the only trilobite fauna of Normanskill age yet found between Newfoundland and Virginia. Curiously, although the genera are those found in Newfoundland, many of the species are so far known from this locality only. A positive correlation can not be made with present knowledge, but the presence of Ectenonotus, Bathyurellus, and Acidiphorus indicates that the fauna is of about the same age as that of divisions K and M of Newfoundland.

Trilobites of the Lower Middle Ordovician in Virginia and Tennessee.

The Lenoir, Holston, Athens, and Ottosee are four formations about whose correlation there is still considerable of difference of opinion. The Lenoir is the oldest, and at many localities, the Holston rests upon it. In many other places, the Athens rests upon the Lenoir. The Ottosee at the typical locality rests upon the Holston, and the two usually are found in the same section, but at a few localities the Ottosee rests upon the Athens where no Holston is present. The Lenoir is always a dark-colored, usually an impure limestone. The Holston is nearly always light-colored, generally coarse-grained, often

a "marble," but never metamorphic. The Athens is a dark gray to black shale with, usually, a considerable number of layers of thinly bedded limestone in one or more zones. Graptolites are present, particularly in the lower part, and the fauna is that of the Normanskill, with *Nemagraptus gracilis*, Dicellograptus, etc. The Ottosee is typically a greenish shale with more or less thinly bedded impure limestone of the same color. The fossils are chiefly from the limestone. Graptolites (Dendroidea) are present, but not common.

The Lenoir.

The fauna of the Lenoir is still very imperfectly known, and I have not explored it very extensively for trilobites. In the typical region, in the vicinity of Knoxville, these fossils are not very common. Most of my material from the Lenoir has been obtained from three somewhat widely separated localities.

South Knoxville, Tenn., and vicinity.

Illaenus fieldi Raymond, *Bumastus limbatus* Raymond, *B. lioderma* Raymond, *Encrinurus nodosarius* Raymond, *Pliomerops canadensis* (Billings).

Bluff City, Tenn.

About 100 miles northeast of Knoxville.

Robergia marginalis Raymond, *Bathyurellus* sp. ind., *Homotelus obtusus* (Hall), *H. laevis* Raymond, *Vogdesia bearsi* Raymond, *Bumastus globosus* (Billings), *B. aplatus* Raymond, *Acrolichas* sp. ind., *Glaphurus decipiens* Raymond, *Ceraurus granulosus* Raymond and Barton, *Ceraurus* sp. ind., *Sphaerexochus parvus* Billings, *Pterygometopus gracilens* Raymond.

Catawba Valley, Va.

About 230 miles northeast of Bluff City.

Remopleurides canadensis Billings, *Illaenus fieldi* Raymond, *I. lautus* Raymond, *I. valvulus* Raymond, *Bumastus lioderma* Raymond, *Homotelus obtusus* (Hall), *H. indentus* Raymond, *Glaphurus decipiens* Raymond, *Acrolichas minganensis* (Billings), *Ceraurus hudsoni* Raymond, *Nieszkowskia* sp. ind., *Pterygometopus annulatus* Raymond.

It will be noted that there is no species which is found at all three

localities, but that two species, *Illaenus fieldi* and *Bumastus lioderma*, are found both at South Knoxville and the Catawba Valley. *Homotelus obtusus* and *Glaphurus decipiens* are common to Bluff City and the Catawba Valley, so that four of the species in the Virginian locality are found in one or the other of the more typical regions in Tennessee.

The trilobites of the Lenoir, so far as known, have a decidedly Chazyan aspect. *Remopleurides canadensis, Homotelus obtusus, Bumastus limbatus, B. globosus, B. aplatus, Vogdesia bearsi, Acrolichas minganensis, Ceraurus hudsoni, C. granulosus, Pliomerops canadensis, Sphaerexochus parvus,* and *Pterygometopus annulatus,* nearly half the species, are found in the typical Chazy of the Champlain Valley. The other species, with three exceptions, belong to genera found in the Chazy, Glaphurus and Nieszkowskia being restricted to it in this country. The only unusual occurrences are species of Robergia, Encrinurus, and Ceraurinus and there is nothing very remarkable about their presence at this horizon.

It would be unsafe, on the basis of trilobites alone, to try to correlate the strata at any one of these three localities with any particular part of the typical Chazy. In that group trilobites are particularly common at two horizons, at the top of the Lower Chazy, and at the base of the Upper Chazy, the Middle Chazy having produced numerous trilobites at only one locality.

Bumastus globosus, Sphaerexochus parvus, Pliomerops canadensis, and *Pterygometops annulatus* range through the three divisions of the typical Chazy. *Homotelus obtusus, Bumastus limbatus,* Nieszkowskia, and Glaphurus belong to the Upper Chazy. *Remopleurides canadensis, Vogdesia bearsi, Ceraurus hudsoni,* and *C. granulosus* are found in the Middle Chazy, and *Acrolichas minganensis* in the Middle and Upper. *Bumastus aplatus* has been found previously only at the top of the Lower Chazy.

The general resemblance is, therefore, to the fauna of the Middle and Upper Chazy.

The Holston.

The present state of knowledge of the Holston fauna is as inadequate as that of the Lenoir. The "Tennessee marbles" are usually extremely fossiliferous, but it is very difficult to obtain good specimens.

The first three of the following lists, from the vicinity of Knoxville, Tenn., and the two localities in Bland County, Va., probably represent some of the more common species of the typical marble. The locality

at the Thomas farm, near Blacksburg, Va., is in the limestone at the top of the Holston, near the contact with the Athens, and represents an association not found elsewhere.

Vicinity of Knoxville, Tenn.

This includes the Ross Republic and other quarries in South Knoxville and the large quarry at Concord, Tenn.

Eoharpes sp. ind., *Illaenus fieldi* Raymond, *I. lautus* Raymond, *Bumastus longiops* Raymond, *B. lioderma* Raymond, *B. dispassus* Raymond (Fountain City, Tenn.).

McNutt quarry, Sharon Springs, Bland Co., Va.

Basilicus laeviculus Raymond, *Hyboaspis shuleri* Raymond, *Illaenus fieldi* Raymond, *Bumastus longiops* Raymond, *B. lioderma* Raymond, *Acrolichas minganensis* (Billings), *A. prominulus* Raymond, *Sphaerexochus discrepans* Raymond.

Hoge farm, near Bland, Va.

Bronteopsis gregaria Raymond, *Homotelus indentus* Raymond, *Illaenus fieldi* Raymond, *Bumastus longiops* Raymond, *Cybeloides* sp. ind., *Ceraurus hudsoni* Raymond, *Sphaerexochus parvus* Billings, *Pterygometopus holstonensis* Raymond.

Thomas farm, three miles northeast of Blacksburg, Va.

Arthrorhachis elspethi Raymond, *Ampyx camurus* Raymond, *Eoharpes* sp. ind., *Homotelus obtusus* (Hall), *Illaenus protuberans* Raymond, *Bumastus longiops* Raymond, *Nileus scrutator* Billings, *Bronteopsis gregaria* Raymond, *Calymene* sp. ind., *Onchaspis confraga* Raymond, *Ceraurus granulosus* Raymond and Barton, *Sphaerexochus parvus* Billings, *S. discrepans* Raymond, *Pterygometopus transsectus* Raymond.

Murat limestone, Lexington, Va.

Bumastus longiops Raymond, *B. lioderma* Raymond.

Comparison of faunas of Lenoir and Holston.

If the fauna of the Lenoir near Knoxville be compared with that of the Holston of the same region, only one species, *Bumastus lioderma*, is found common to both.

If the first three lists combined be considered as affording a representative Holston fauna, and this list compared with a list of the Lenoir species, excluding those recorded from the Catawba Valley in Va., all formations about which there is any doubt as to correlation will be excluded. In these two lists, three species are found, namely:— *Illaenus fieldi*, *Bumastus lioderma*, and *Sphaerexochus parvus*.

The Chazyan aspect of the Holston is well indicated by the presence of Eoharpes, Basilicus, Hyboaspis, *Acrolichas minganensis*, *Sphaerexochus parvus*, Cybeloides, and *Ceraurus hudsoni*. Again, Middle and Upper Chazy are indicated.

The peculiar mixed fauna of the Holston on the Thomas farm will be mentioned again in the discussion of the fauna of the Athens.

The strata in the Catawba Valley which I have here called Lenoir, might with equal propriety be termed Holston. Comparing the list of its trilobites with the restricted lists of Lenoir and Holston faunas, it will be noted that *Illaenus lautus*, *Bumastus lioderma*, *Acrolichas minganensis* and *Ceraurus hudsoni* occur both in the Catawba Valley and in the Holston. On the other hand, *Illaenus fieldi*, *Bumastus lioderma*, *Homotelus obtusus* and *Glaphurus decipiens* are common to the strata in the Catawba Valley and the typical Lenoir. Whatever be the correct correlation, it is obvious that although the Lenoir and Holston faunas appear unlike in the typical region in eastern Tennessee, they really belong to the same stock.

The Athens.

Trilobites are found at several horizons in the Athens, and the species differ somewhat at different localities. The section at the typical locality, Athens, Tenn., is poor, because of lack of good exposures in the lower part.

Athens, Tenn.

Shale along railroad two miles northeast of Athens. Not far above base of the formation.

Arthrorhachis elspethi Raymond, *Trinucleus acervulosus* Raymond, *Lonchodomas politus* Raymond, *Telephus troedssoni* Raymond, *Homotelus* sp. ind., *Nemagraptus*, *Dicellograptus*, etc.

Thin-bedded limestone high in the Athens, near school house two miles northeast of Athens.

Ampyx americanus Safford and Vogdes, *Homotelus laevis* Raymond, *Isotelus* sp. ind., *Ceraurus* sp. ind.

Vicinity of Bullsgap, Tenn.

Thin-bedded limestone at base of Athens between Bullsgap and Whitesboro.

Ampyx americanus Safford and Vogdes, *Homotelus laevis* Raymond, *Bumastus lioderma* Raymond, *Pterygometopus annulatus* Raymond.

Thin-bedded limestone high in Athens under railroad bridge over creek at Bullsgap. This is the type-locality for the first species.

Ampyx americanus Safford and Vogdes, *Nileus scrutator* Billings.

A limestone which appears to be the same as this is shown in a large cutting near Otes, about seven miles north of Bullsgap. It furnished:—

Arthrorhachis elspethi Raymond, *Ampyx americanus* Safford and Vogdes, *Raphiophorus* sp. ind., *Lonchodomas politus* Raymond, *Nileus scrutator* Billings, *Homotelus laevis* Raymond, *Illaenus fieldi* Raymond, *Bronteopsis gregaria* Raymond, *Ceraurus tenuicornis* Raymond, *Pterygometopus annulatus* Raymond.

Saltville, Va.

In thin-bedded impure limestone and shale at base of Athens.

Ampyx americanus Safford and Vogdes, *Raphiophorus powelli* Raymond, *Robergia major* Raymond, *Telephus* sp. ind., *Triarthrus caecigenus* Raymond, *Homotelus laevis* Raymond, *Nileus scrutator* Billings.

Blacksburg, Va.

Trinucleus acervulosus Raymond, *Dionide holdoni* Raymond, *D. contrita* Raymond, *Triarthrus caecigenus* Raymond.

Catawba Valley, north of Salem, Va.

In shale, associated with typical Normanskill graptolites.

Raphiophorus powelli Raymond, *Cryptolithus* sp. ind., *Robergia schlotheimi* (Billings), *Triarthrus caecigenus* Raymond.

In thin-bedded limestone which forms upper part of Athens.

Raphiophorus powelli Raymond, *Ampyx americanus* Safford and Vogdes.

Lexington, Va.

Base of the Liberty Hall limestone.

Ampyx camurus Raymond, *Remopleurides canadensis* Billings, *Homotelus obtusus* (Hall), *Illaenus fieldi* Raymond, *Bronteopsis gre-*

garia Raymond, *Acrolichas minganensis* (Billings), *Ceraurus granulosus* Raymond and Barton, *Sphaerexochus parvus* Billings.

In the Athens at Athens, Tenn., at Saltville in southwestern Virginia, and in the Catawba Valley of central Virginia, one finds trilobites with the graptolites of the Nemagraptus or Normanskill fauna, so that the comparison with the faunas in the Lower Dicellograptus beds of Sweden is particularly close. At these localities, the following species have been found directly associated with graptolites:—

Arthrorhachis elspethi Raymond, *Trinucleus acervulosus* Raymond, *Lonchodomas politus* Raymond, *Raphiophorus powelli* Raymond, *Ampyx americanus* Safford and Vogdes, *Cryptolithus* sp. ind., *Robergia schlotheimi* (Billings), *R. major* Raymond, *Telephus troedssoni* Raymond, *Telephus* sp. ind., *Triarthrus caccigenus* Raymond, *Nileus scrutator* Billings, *Homotelus laevis* Raymond.

These species are, therefore, undoubtedly of Normanskill age, and enough of them occur in the other faunas listed to indicate that all, except possibly that from Lexington, Va., are approximately contemporaneous. The typical Normanskill in New York has not yet been found to carry trilobites in the same strata with the graptolites.

The Athens contains trilobites of two categories, those adapted to a pelagic life, and those more at home in a benthonic habitat. It will be noted that with the exception of *Homotelus laevis*, all the species so far found associated with graptolites are either blind or have very large eyes, either condition indicative of life in a region of feeble light, and most of them have broad flattened bodies and thin tests, some of them spinose. With few exceptions they appear to have been trilobites which were active swimmers, could float with little effort, and were particularly adapted to life on a muddy bottom, where, skimming along the surface of the soft ooze, they could gather decaying food inaccessible to heavier and truly benthonic creatures.

In the more calcareous beds are found some of these same animals, but in addition, such "normal" types as Ceraurus, Illaenus, Homotelus, and Pterygometopus.

Comparison of the Athens with Holston and Lenoir faunas.

Eight of the twenty-five species here listed as belonging to the Athens fauna are found in the Lenoir. These are:—

Remopleurides canadensis Billings, *Homotelus obtusus* (Hall), *Illaenus fieldi* Raymond, *Bumastus lioderma* Raymond, *Acrolichas minganensis* (Billings), *Ceraurus granulosus* Raymond and Barton, *Sphaerexochus parvus* Billings, *Pterygometopus annulatus* Raymond.

No one of the above trilobites is, however, found associated with graptolites, and hence they are not a part of the typical element of the Normanskill fauna.

The number of species common to the Athens and the Holston is about the same. They are:—

Arthrorhachis elspethi Raymond, *Ampyx camurus* Raymond, *Nileus scrutator* Billings, *Illaenus fieldi* Raymond, *Bumastus lioderma* Raymond, *Bronteopsis gregaria* Raymond, *Acrolichas minganensis* (Billings), *Ceraurus granulosus* Raymond and Barton, *Sphaerexochus parvus* Billings.

It will be noted that five of these species are found in the Lenoir, Holston, and Athens, but that the other four are of the more strictly Normanskill type. The first three are, however, found in the Holston at only one locality, the Thomas farm near Blacksburg, Va., which, as has already been pointed out, has not a normal Holston fauna.

Six of the species of the Athens are found in the Chazy of New York and Vermont:—

Remopleurides canadensis Billings, *Homotelus obtusus* (Hall), *Acrolichas minganensis* (Billings), *Ceraurus granulosus* Raymond and Barton, *Sphaerexochus parvus* Billings, *Pterygometopus annulatus* Raymond.

All of these are also found in either the Lenoir or the Holston.

The Trilobites of the Ottosee.

Trilobites are not common in the typical Ottosee, in fact, they are practically absent from the formation in Tennessee, but are met with occasionally in Virginia. The list is, however, short.

Speers Ferry, Va.

Illaenus fieldi Raymond, *Bumastus lioderma* Raymond.

Fugates Hill, north of Mendota, Va.

Eoharpes sp. ind., *Bronteopsis gregaria* Raymond, *Illaenus fieldi* Raymond, *Ceraurus hudsoni* Raymond.

Saltville, Va.

Lonchodomas politus Raymond, *Pterygometopus annulatus* Raymond.

At Speers Ferry and Fugates Hill, the Ottosee overlies the Holston. At Saltville the Athens intervenes between the Holston and Ottosee.

In all these localities the formation is much more calcareous than about Knoxville in Tennessee, where it is largely a green shale. As may be seen, the small fauna contains species found in the Holston and Athens chiefly, although some persist from the Lenoir.

Comparison of the Lower Middle Ordovician Trilobites of Tennessee and Virginia with those of other regions.

Newfoundland.

In a broad general way, there are great similarities between the faunas of the Lenoir, Holston, and Athens on the one hand, and of divisions I, K, L, M, and N on the other. The Lenoir and Holston are limestones, as are I, K, L, and M, whereas the Athens is composed of thinly bedded limestone and shale, a condition somewhat paralleled in N. In the limestones of both regions we find such genera as Illaenus, Pliomerops, and Sphaexreochus, accompanied by other genera suggesting the normal Chazyan fauna, followed in both cases by an influx of so-called European genera, such as Raphiophorus, Ampyx, Robergia, Telephus, Bronteopsis, Nileus, etc.

When detailed comparison is made, however, the differences are fully as great as the 1,500 miles which separate the two regions would lead us to expect. There are few species in common and my identification of these will probably be questioned. There are, however, many species in the Athens which are closely allied to forms in divisions M or N as shown in the following lists:—

Athens.	*Divisions M or N.*
Arthrorhachis elspethi Raymond,	*A. galba* (Billings).
Raphiophorus powelli Raymond,	*R. semicostatus* (Billings).
Lonchodomas politus Raymond,	*L. normalis* (Billings).
Ampyx americanus Safford and Vogdes,	*A. laeviusculus* Billings.
A. camurus Raymond,	
Remopleurides canadensis Billings,	*R. panderi* Billings.
Robergia schlotheimi (Billings),	*R. schlotheimi* Billings.
R. major Raymond,	
Triarthrus caecigenus Raymond,	*T. fischeri* Billings.
Telephus troedssoni Raymond,	*T. americanus* Billings.
T. sp. ind.	
Bronteopsis gregaria Raymond,	*B. gregaria* Raymond.
	B. scotica Nicholson and Etheridge.

Athens.	*Division M or N.*
Nileus scrutator Billings,	*N. scrutator* Billings.
	N. macrops Billings.
Illaenus fieldi Raymond,	*I. fraternus* Billings.
Sphaerexochus parvus Billings,	*S. desertus* (Billings).

Striking differences are noted in the presence of Endymionia, Anisonotus, Bathyurellus, Niobe, and Megalaspis in Newfoundland, and the presence in Virginia and Tennessee of Dionide, Trinucleus, Homotelus, Bumastus, Ceraurus, and Pterygometopus. The similarities are, however, sufficient to indicate that the two faunas are nearly or quite contemporaneous, particularly when both faunas are compared with those of northern Europe.

Girvan District, Scotland.

The fauna of the Lenoir, Holston, and Athens compared with that of the Lower Middle Ordovician of the Girvan District, shows about the same similarities as were noted when the trilobites of Newfoundland were so compared on a previous page. The bulk of the allied species are found in the comparison of the faunas of the Athens and the Balclatchie, but it will be noted that Dionide occurs in the Whitehouse Group in Scotland, above the Balclatchie and in strata referred by Reed to the lower part of the Caradoc. This genus is, however, known to range from top to bottom of the Ordovician.

Lenoir or Holston.	*Stinchar limestone.*
Ampyx camurus Raymond,	*A. cf. foveolatus* Angelin.
Illaenus fieldi Raymond,	*I. latus* McCoy.
	I. portlocki Salter.
Acroliehas minganensis Billings,	*A. hibernicus* (Portlock).
Encrinurus nodosarius Raymond,	*E. arenaceus* Salter
Calymene sp. ind.,	*C. cambrensis* Salter.
Ceraurus granulosus Raymond and Barton,	*C. gelasinosus* (Portlock).
Sphaerexochus parvus Billings,	*S. balclatchiensis* Reed.
S. discrepans Raymond,	
Pliomerops canadensis (Billings),	*Pliomera* sp. ind.
Pterygometopus annulatus Raymond,	*P. brongniarti* (Portlock).

Athens.	*Balclatchie group.*
Arthrorhachis elspethi Raymond,	*A. girvanensis* Reed.
Cryptolithus sp. ind.,	*C. subradiatus* (Reed).

Athens.	*Balclatchie group*
Lonchodomas politus Raymond,	*L. maccallumi* (Salter).
Ampyx americanus Safford and Vogdes,	*A. austini* Portlock.
Triarthrus caecigenus Raymond,	*T. reedi* Raymond.
Robergia major Raymond,	*R. barrandei* (Etheridge and Nicholson).
R. scholtheimi (Billings),	
Remopleurides canadensis Billings,	*R. girvanensis* Reed.
T. troedssoni Raymond,	*T. salteri* Reed.
T. sp. ind.,	
Homotelus laevis Raymond,	*H. grayae* (Reed).
Illaenus fieldi Raymond,	*I. peachi* Reed.
Bumastus lioderma Raymond,	*B. richardsoni* (Reed).
Bronteopsis gregaria Raymond,	*B. ardmillanensis* Reed.
Acrolichas minganensis (Billings),	*A. hibernicus* (Portlock).
Ceraurus granulosus Raymond and Barton,	*C. gelasinosus* (Portlock).
Sphaerexochus parvus Billings,	*S. balclatchiensis* Reed.
Pterygometopus annulatus Raymond,	*P. brongniarti* (Portlock).
	P. hunteri Reed.

Athens.	*Whitehouse group.*
Dionide holdoni Raymond,	*D. lapworthi* Etheridge and Nicholson.
D. contrita Raymond,	*D. richardsoni* Reed.
Telephus troedssoni Raymond,	*T. fractus* Barrande.

EXPLANATION OF THE PLATES.

PLATE 1.

PLATE 1.

Fig. 1. *Agnostus nudus* (Beyrich). A natural cast of the shield usually called the pygidium, showing the course of the suture. × 4.

Fig. 2, 3. *Arthrorhachis elspethi* Raymond. A cephalon and pygidium from the typical locality. × 4.

Fig. 4. *Arthrorhachis elspethi* Raymond. A pygidium from near Otes, Tenn., showing the "knees" for articulation. × 3⅓.

Fig. 5, 6. *Arthrorhachis longicollis* Raymond. Cephalon and pygidium. × 4.

Fig. 7. *Peronopsis munda* Raymond. A pygidium. × 6.

Fig. 8. *Eoharpes uniserialis* Raymond. A natural cast of the interior. × 2.

Fig. 9. *Eoharpes uniseriales* Raymond. A specimen showing the interior of the test. × 2.

Fig. 10, 11. *Eoharpes fragilis* Raymond. Two incomplete cephala. × 1⅓.

Fig. 12, 13. *Dionide jubata* Raymond. Two nearly complete specimens, one lacking the genal spines. × 2.

Fig. 14. *Raphiophorus semicostatus* (Billings). A nearly complete cephalon, retaining the spine. × 2⅔.

Fig. 15. *Raphiophorus semicostatus* (Billings). A fairly complete but distorted specimen, lacking the spine. × 2⅔.

Fig. 16. *Dionide holdoni* Raymond. Specimen with a damaged cephalon. × 2. MCZ 1825

Fig. 17. *Dionide holdoni* Raymond. A cephalon and part of thorax, retaining surface markings. × 2⅔.

Fig. 18. *Trinucleus acervulosus* Raymond. The holotype. × 2.

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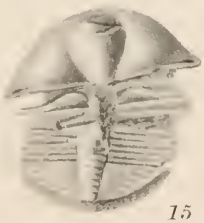

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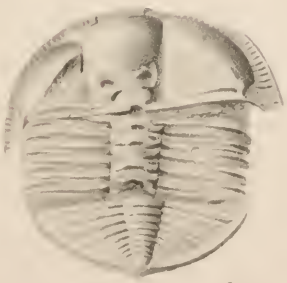

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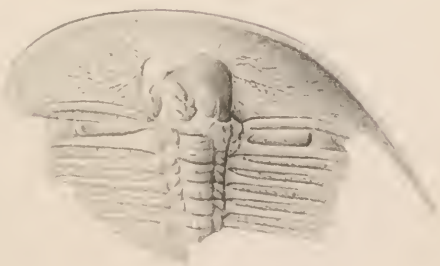

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Elvira Wood, del.

PLATE 2.

PLATE 2.

Fig. 1. *Raphiophorus powelli* Raymond. The holotype, which lacks the anterior spine. × 2⅔.

Fig. 2. *Raphiophorus powelli* Raymond. A specimen which has the peculiar lateral lobes of an Ampyxina, only four segments in the thorax, and extra ribs on the pygidium. The axial lobe is damaged. × 3⅓.

Fig. 3. *Ampyx americanus* Safford and Vogdes. A nearly complete specimen from the original locality. × 2.

Fig. 4. *Ampyx americanus* Safford and Vogdes. A pygidium with ribs. × 1⅓.

Fig. 5–7. *Ampyx camurus* Raymond. A cranidium and pygidium. × 2.

Fig. 8–10. *Lonchodomas politus* Raymond. Two cranidia and a pygidium. × 2.

Fig. 11. *Lonchodomas sublaevis* Raymond. The outline of a somewhat distorted specimen. × 1.

Fig. 12. *Lonchodomas sublaevis* Raymond. Part of a cranidium. × 1⅓.

Fig. 13. *Endymionia schucherti* Raymond. A very complete cranidium. × 2.

Fig. 14. *Crepicephalus* sp. ind. Possibly the same species as the pygidium beside it. × 4.

Fig. 15. *Crepicephalus ceratopygoides* Raymond. A somewhat damaged pygidium. × 1.

Fig. 16. *Triarthrus caecigenus* Raymond. The holotype. × 3⅓.

Fig. 17. *Anisonotus glacialis* (Billings). A specimen which lacks only the free cheeks. × 2⅔.

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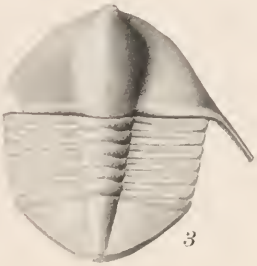

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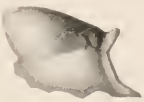

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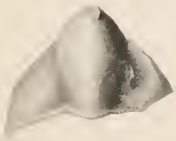

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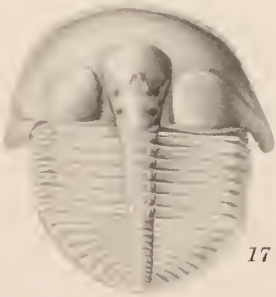

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Elvira Wood, del

PLATE 3.

PLATE 3.

Fig. 1, 2. *Ischyrotoma twenhofeli* Raymond. Dorsal and lateral views of the type. × 2.

Fig. 3. *Remopleurides rugicostatus* Raymond. The thorax of an enrolled specimen. × 3.

Fig. 4, 5. *Remopleurides striatulus* Walcott. The holotype and an hypostoma. × $1\frac{2}{3}$.

Fig. 6. *Robergia major* Raymond. An imperfect cranidium. × 2.

Fig. 7. *Robergia major* Raymond. A free cheek. × $2\frac{2}{3}$.

Fig. 8. *Robergia major* Raymond. A pygidium from which the test of the pleural lobes has been removed, revealing the doublure. × $2\frac{2}{3}$.

Fig. 9. *Robergia major* Raymond. A cranidium with part of an eye and free cheek. × $2\frac{2}{3}$.

Fig. 10. *Robergia major* Raymond. A part of the thorax. × $2\frac{2}{3}$.

Fig. 11. *Robergia marginalis* Raymond. An incomplete cranidium. Both palpebral lobes are damaged, and so appear much too small in the drawing. × $2\frac{2}{3}$.

Fig. 12. *Bronteopsis gregaria* Raymond. An incomplete cranidium. Glabella with unusually prominent median ridge. × 2.

Fig. 13, 14. *Bronteopsis gregaria* Raymond. Two pygidia; the radial markings of that shown in Fig. 13 are unusual. × 2.

Fig. 15, 16. *Niobe lineolata* Raymond. Two incomplete specimens; Fig. 15 is the holotype. × 2.

Fig. 17. *Nileus scrutator* Billings. An hypostoma. × 2.

Fig. 18. *Bathyurellus abruptus* Billings. An hypostoma, viewed from within. × $2\frac{2}{3}$.

Fig. 19. *Bathyurellus fraternus* Billings. A specimen from which the genal spines and other parts of the cephalon have been broken. × 1.

Fig. 20. *Niobe quadraticaudata* (Billings). An hypostoma. × $1\frac{1}{3}$.

Fig. 21. *Xenostegium shepardi* Raymond. The holotype. × 1.

Fig. 22. *Hemigyraspis mcconnelli* Raymond. A pygidium. × 1.

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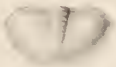
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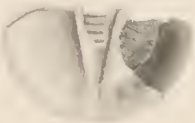
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PLATE 4.

PLATE 4.

Fig. 1. *Homotelus elongatus* Raymond. A much damaged specimen. × ⅔.

Fig. 2. *Homotelus elongatus* Raymond. Profile view of the cephalon and pygidium of an incomplete enrolled specimen. × ⅔.

Fig. 3. *Homotelus elongatus* Raymond. A normal specimen. × ⅔.

Fig. 4, 5. *Homotelus laeviurus* Raymond. Cranidium and pygidium. × 1.

Fig. 6. *Homotelus indentus* Raymond. An enlargement of a part of the test, to show the large shallow puncta. × 2⅔.

Fig. 7, 8. *Homotelus obtusus* (Hall). A cranidium and pygidium. × 1.

Fig. 9, 10. *Ectenaspis homalonotoides* (Walcott). Pygidium and cranidium, drawn from plaster casts of the types. × 1.

Fig. 11, 12. *Illaenus lautus* Raymond. Dorsal and outline profile views of a cranidium. × 2.

Fig. 13, 14. *Illaenus valvulus* Raymond. A cranidium, and a pygidium to which one thoracic segment is attached. × 1⅓.

Fig. 15, 16. *Basilicus laeviculus* Raymond. An incomplete free cheek and a pygidium, the latter drawn from an artificial cast of a natural mould. × ⅔.

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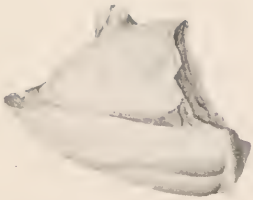

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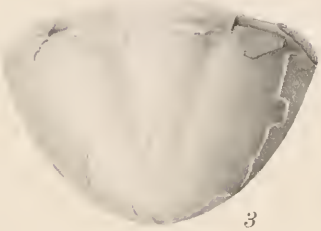

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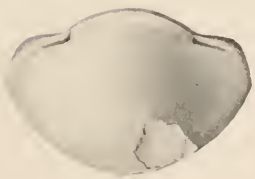

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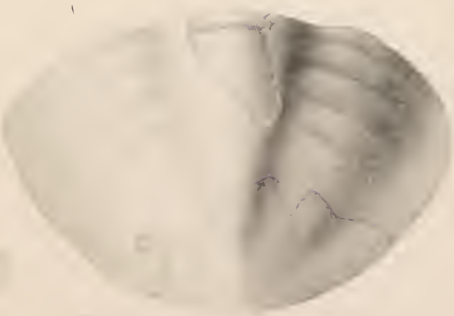

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PLATE 5.

PLATE 5.

Fig. 1, 2. *Hyboaspis depressa* Raymond. Two pygidia. × 1.

Fig. 3, 4. *Hyboaspis shuleri* Raymond. A small and a large pygidium. × 1.

Fig. 5. *Homotelus catactus* Raymond. An incomplete cranidium. × ⅔.

Fig. 6. *Isotelus rejuvenis* Raymond. The pygidium of the holotype. × ⅔.

Fig. 7. *Homotelus indentus* Raymond. A pygidium showing the peculiar indentation of the posterior end. × ⅔.

Fig. 8. *Hyboaspis shuleri* Raymond. Outline profile of the pygidium shown in Fig. 4. × 1.

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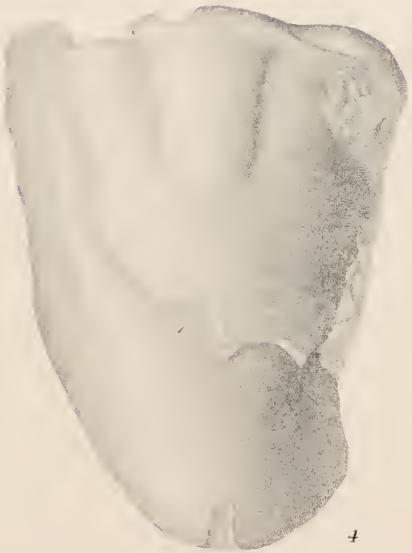

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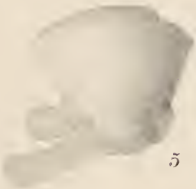

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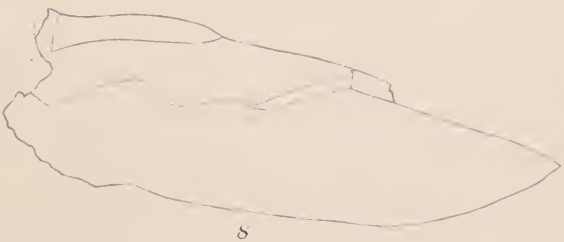

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PLATE 6.

PLATE 6.

Fig. 1, 2. *Homotelus gratiosus* Raymond. An enrolled specimen which lacks the cranidium. × $\frac{1}{2}$.

Fig. 3. *Homotelus ulrichi* Raymond. The holotype. × about $\frac{2}{3}$.

Fig. 4, 5. *Homotelus ulrichi* Raymond. Two views of an enrolled specimen, part of whose pygidium has been removed to show the doublure of the cephalon. × about $\frac{3}{4}$.

Fig. 6. *Harpes telleri* Weller. Two cephala, viewed from the lower surface. × $\frac{1}{2}$.

Fig. 7. *Onchometopus volborthi* Schmidt. Specimen showing the narrow, hooked doublure and hypostoma. M. C. Z. 1,065. × about 1.

Fig. 8. *Vogdesia gigas* Raymond. The holotype. × $\frac{1}{2}$.

Fig. 9. *Dionide contrita* Raymond. The holotype. × about $1\frac{1}{5}$.

Fig. 10. *Niobe morrisi* (Billings). A pygidium. × about $\frac{1}{2}$.

Fig. 11. *Megalaspis huttoni* (Billings). A natural mould of a pygidium. × $\frac{1}{2}$.

Fig. 12. *Platylichas inconsuetus* Raymond. A cranidium. × about $\frac{3}{5}$.

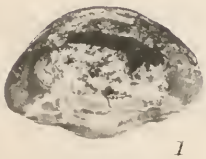
Fig. 13. *Niobe quadraticaudata* (Billings). A nearly complete specimen. × $\frac{5}{7}$.

Fig. 14. *Niobe lindstroemi* Schmidt. An incomplete specimen for comparison with the preceding. M. C. Z. 1,055. × $\frac{3}{4}$.

Fig. 15. *Basilicus laeviculus* Raymond. The posterior part of a cranidium. × $\frac{5}{8}$.

Fig. 16. *Illaenus viator* Raymond. A natural mould of a nearly complete specimen. × $\frac{1}{2}$.

Fig. 17. *Illaenus viator* Raymond. A partially enrolled specimen and its natural mould. × $\frac{1}{2}$.



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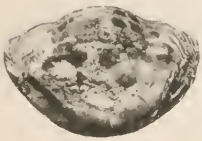

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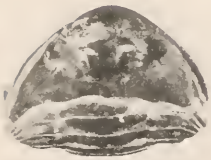

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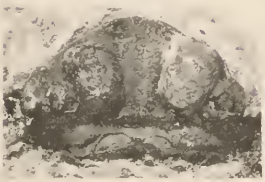

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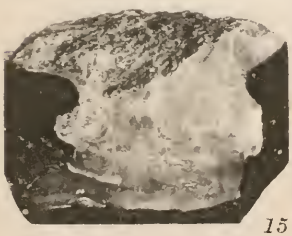

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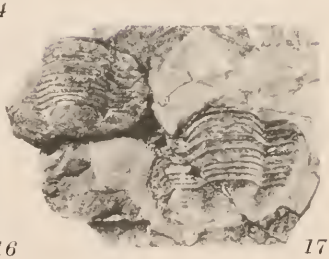

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George Nelson, del.

PLATE 7.

PLATE 7.

Fig. 1–4. *Illaenus fieldi* Raymond. Three cranidia, one of them in profile, and a pygidium. × 1.

Fig. 5. *Illaenus alveatus* Raymond. Profile of a cranidium. × 1.

Fig. 6. *Bumastus dispassus* Raymond. The holotype. × 1.

Fig. 7. *Bumastus comes* Raymond. The holotype. × 1.

Fig. 8, 9. *Illaenus marginalis* Raymond. Cranidium and pygidium. × 1.

Fig. 10, 11. *Bumastus lioderma* Raymond. Two cranidia, one in profile, the other in dorsal aspect. × 1.

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PLATE 8.

PLATE 8.

Fig. 1, 2. *Illaenus protuberans* Raymond. Dorsal view of holotype, and outline profile of same. × 2.

Fig. 3, 4. *Bumastus aplatus* Raymond. Cranidium and pygidium. × 1.

Fig. 5, 6. *Bumastus holei* Foerste. Profile and dorsal views of a complete specimen. × 1.

Fig. 7, 8. *Bumastus porrectus* Raymond. Dorsal and profile views of a perfect specimen. × 1.

Fig. 9. *Cyphaspis slocomi* Raymond. The holotype. × 4.

Fig. 10. *Hemiarges bartoni* Raymond. An incomplete cranidium. ×2⅔.

Fig. 11, 12. *Acrolichas prominulus* Raymond. Dorsal view and outline profile of the type. × 1.

Fig. 13. *Onchaspis confraga* Raymond. A fragmentary cranidium. × 2⅔.

Fig. 14. *Encrinurus nodosarius* Raymond. The pygidium. × 2⅔.

Fig. 15. *Acidiphorus spinifer* Raymond. Lateral view of a pygidium lacking the terminal spine. × 2.

Fig. 16. *Acidiphorus scorpionis* Raymond. Dorsal view of the pygidium. × 3⅓.

Fig. 17. *Acidiphorus spinifer* Raymond. Lateral view of a pygidium. × 2.

Fig. 18, 19. *Bumastus longiops* Raymond. A cranidium and pygidium. × 2.

Fig. 20. *Glaphurus decipiens* Raymond. A nearly complete cranidium. × 1⅔.

Fig. 21. *Nieszkowskia* sp. ind. An imperfect pygidium. × 1⅓.

Fig. 22. *Ceraurus angustus* Raymond. The holotype. × 1⅓.

Fig. 23. *Ceraurus tenuicornis* Raymond. The pygidium and part of a thoracic segment. × 2⅔.

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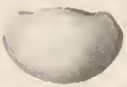
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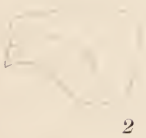
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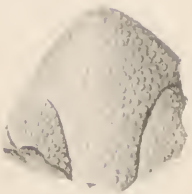
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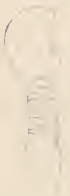
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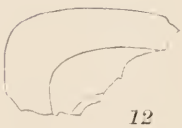
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PLATE 9.

PLATE 9.

Fig. 1. *Ceraurus ruedemanni* Raymond. A cranidium from the original locality. × 1.

Fig. 2. *Homotelus indentus* Raymond. A pygidium. × 1.

Fig. 3, 4. *Homotelus laevis* Raymond. The cotypes. × 1.

Fig. 5, 6. *Hadrohybus dunbari* Raymond. Dorsal and profile views of the type. × 1.

Fig. 7. *Ectenaspis beckeri* (Slocom). The holotype. The eyes are unknown, and the restoration of them is wholly conjectural. × 1.

Fig. 8. *Cybeloides iowensis* Slocom. A pygidium. × 3.

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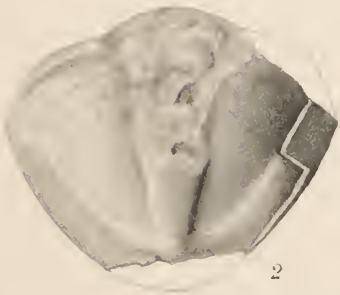

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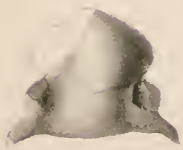

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PLATE 10.

PLATE 10.

Fig. 1. *Sphaerexochus romingeri* Hall. A nearly entire, enrolled specimen. × 2.

Fig. 2. *Sphaerexochus romingeri* Hall. Anterior view of the cephalon, showing the hypostoma and its relation to the cheeks. × 2.

Fig. 3, 4. *Sphaerexochus discrepans* Raymond. Two glabellae. × 2.

Fig. 5. *Sphaerexochus parvus* Billings. A pygidium. × 6.

Fig. 6, 7. *Pliomerops bilirata* Raymond. Dorsal and anterior views of the cephalon. × 2.

Fig. 8. *Nieszkowskia excelsus* Raymond. A drawing of an artificial cast made from the natural mould which is the type. × 1.

Fig. 9. *Pterygometopus holstonensis* Raymond. An incomplete cranidium, the holotype. × 2.

Fig. 10. *Pterygometopus holstonensis* Raymond. A small glabella with a palpebral lobe. × 1⅓.

Fig. 11. *Pterygometopus holstonensis* Raymond. A pygidium. × 2.

Fig. 12. *Pterygometopus transsectus* Raymond. The holotype. × 3⅓.

Fig. 13. *Perischoclonus capitalis* Raymond. The holotype. × 2.

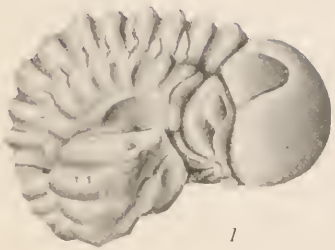
Fig. 14. *Pliomerops trouti* Raymond. The holotype. × 1⅓.

Fig. 15. *Pliomerops nevadensis* (Walcott). A very fragmentary cranidium. × ⅔.

Fig. 16. *Pterygometopus annulatus* Raymond. A cephalon. × 1⅓.

Fig. 17. *Pterygometopus annulatus* Raymond. A pygidium. × 2.

Fig. 18. *Pterygometopus gracilens* Raymond. The holotype. × 2.



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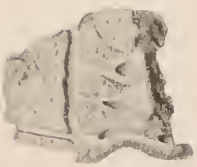

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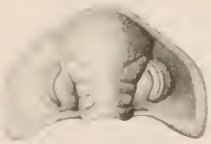

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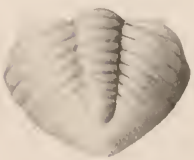

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MAY 28 1925

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LXVII. No. 2.

THE SYSTEMATIC POSITION OF PALAEOSPIZA BELLA ALLEN, WITH OBSERVATIONS ON OTHER FOSSIL BIRDS.

By Alexander Wetmore.

With Four Plates.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
May, 1925.

No. 2.— *The Systematic Position of Palaeospiza bella Allen, with Observations on other Fossil Birds.*

By Alexander Wetmore.

Introduction.

In the year 1877 Mr. S. H. Scudder obtained near Florissant, Colorado, a slab containing the fossilized remains of a passeriform bird of small size preserved almost entire. The specimen was placed in the hands of Dr. J. A. Allen, then at the Museum of Comparative Zoölogy, for study, and was described by Allen as *Palaeospiza bella* (Bull. U. S. geol. geog. surv. terr., 3 May, 1878, **4**, p. 443–444, pl. 1, fig. 1). The type was deposited for many years in the Boston Society of Natural History, but recently has been transferred to the Museum of Comparative Zoölogy, where it has been mounted in a plaque and placed on exhibition. Thus far our knowledge of Palaeospiza has been based on the original description and it has seemed advisable to submit the type to a second critical examination in the light of advance in knowledge in the nearly fifty years that have elapsed since its discovery. Through the kind coöperation of the authorities of the Museum of Comparative Zoölogy, the type of Palaeospiza was forwarded to the U. S. National Museum at Washington, where it has been compared with a large number of recent birds. The writer is deeply indebted to the Museum for the privilege of this examination.

In the original description the strata from which the type of Palaeospiza came were called the insect-bearing shales of Florissant, while in the list of fossil birds in the third edition of the A. O. U. Check-List, published in 1910 (p. 392), they are recorded as the Amyzon Shales. In more modern nomenclature these deposits are known as the Florissant lake beds, famous for the large numbers of beautifully preserved plants and insects that they have yielded during a period of fifty years. For details regarding the beds in question, I am indebted to a recent paper by Dr. F. H. Knowlton on the fossil plants of this region,[1] in which is given, in the introduction, a résumé of the occurrence of these deposits. Fossils in these strata are believed to have been laid down in the shallow waters of a small lake with an irregular shore line, five

[1] A Review of the Fossil Plants in the United States National Museum from the Florissant Lake Beds at Florissant, Colorado, with Descriptions of new Species and List of Type-Specimens. Proc. U. S. N. M., 24 November, 1916, **51**, p. 241–297, 16 plates.

miles long and a mile wide. The preserved material is supposed to have been buried in volcanic ash, sifted over the country during repeated eruptions, and in mud and sand washed in by rains. As the Florissant beds lie isolated from other sedimentary rock, in deposits of granite, their geologic age must be determined from palaeontological evidence alone. Dr. A. C. Peale, who visited the area in 1873, and gave the first account of its geology, considered them as Pliocene, but Lesquereux, who studied the plants, at first believed them to be upper Miocene, but later, with Cope, called them lower Miocene, or Oligocene, a position assigned them in most current text-books. Further study, particularly of the plants, has indicated that Lesquereux's original assignment was correct, so that Knowlton, the most recent authority to write on the subject, states (*l.c.*, p. 244) that "While it is improbable that the final word has been said regarding the exact stratigraphic position of these beds, until conclusive evidence to the contrary has been presented the Florissant plant-bearing beds may be regarded as upper Miocene."

Though plant and insect remains occur in these beds in abundant profusion, avian fossils have remained rare. *Palaeospiza bella*, the first bird to be described from them, was followed by *Charadrius sheppardianus* Cope (Bull. U. S. geol. geogr. surv. terr., 11 February, 1881, **6**, p. 83), discovered by Dr. G. Hambach and named for Edwin Sheppard, of Philadelphia, according to Cope "an excellent ornithologist and skillful artist." Dr. Knowlton (Proc. U. S. N. M., 1916, **51**, p. 245) has called attention to the curious fact that the type of *Fontinalis pristina* Lesquereux (Rept. U. S. geol. surv. terr., 1883, **8**, p. 135, pl. 21, fig. 9), named as a species of moss, is in reality a section of a feather. The A. O. U. Code seems to make no provision for such cases, but in the International Code it is stated "if, however, an organism is transferred from the vegetable to the animal kingdom, its botanical names are to be accepted in zoölogical nomenclature with their original botanical status."

The type in question must be considered as a definitely named fossil bird though there is little or no hope that a proper relationship may be assigned it.

As Fontinalis does not appear to be preoccupied in zoölogy, *Fontinalis pristina* must be anchored as another weathered derelict in the sad haven of *incertae sedis*, at the close of our check-list of fossils. Both genus and species will have Lesquereux as authority.

Additional fossil remains from the Florissant have been described (but not named) by Shufeldt (Proc. U. S. N. M., 15 August, 1917, **53**,

p. 453–455, 2 pls.), who gave an account of two small slabs containing impressions of bird bones, secured by Prof. I. E. Cutler, of the University of Denver. In the present connection I have examined these specimens and find that they comprise two passeriform species, one represented by an impression of the pelvic and caudal region, and the other, somewhat larger, by the tarsus, foot, and tibio-tarsus. These are too incomplete to warrant further study at present.

Feather remains (in addition to the type of *Fontinalis pristina*) appear fairly numerous, as there are five slabs bearing impressions of this character in the palaeontological collections in the U. S. N. M. Some of these, together with some additional fossil feathers in the same deposits, received from Prof. T. D. A. Cockerell, have been described and figured (but not named) by Dr. R. W. Shufeldt (Journ. geol., 1913, **21**, p. 631–634, 2 figs.).

Description of Palaeospiza bella.

Dr. Allen in his original description says that Palaeospiza represents "a high ornithic type, probably referable to the Oscine division of the Passeres. . . . The absence of the bill renders it impossible to assign the species to any particular family, but the fossil on the whole gives the impression of Fringilline affinities." The species has been carried in the list of fossil birds in the A. O. U. Check-List (third edition, 1910, p. 392) as a questionable member of the Fringillidae, and has usually been considered a finch, in part because of the derivation and form of the generic name.

On the same plaque as the type is mounted an impression of the end of a wing and the tip of a tail of a bird which belongs to another specimen, and has no connection with Palaeospiza. This represents the distal end of the primaries of a bird with a broad, rounded wing tip, with the shafts of the feathers somewhat curved. The distal end of the rectrices appear to have been graduated with strong heavy shafts. The general impression is that these are similar to the wing and tail of a woodpecker, or a dendrocolaptid, but it is of course, impossible to determine their actual affinity.

As has been stated the type of *Palaeospiza bella* consists of a more or less complete bird, which has been flattened by pressure. The slab in which it is preserved has been split and separated, so that two silhouettes are presented (Plates 1–4), with part of the bones of the fossil adherent in one, and a part in the other. The impression given is that the bird originally lay on its breast, with wings folded at the sides

and feet and neck extended. The fossil is preserved as a thin plate impressed on two slabs of grayish stone which, with the fossil itself is soft and friable. In fact, parts of the plate with several fragments of bones have been lost. As the bird is now mounted, the left-hand portion is impressed and the right-hand one elevated and rounded. In color, the bones are dull, yellowish brown, while the feather impressions are blackish. Certain rounded masses, dull brownish in color, in the thoracic region and near parts of the humeri may represent the fossilized remains of dried flesh.

The drawing, executed by Mr. J. H. Blake, that accompanied the original description, is excellent in its fidelity to outline, proportion, conformation and position of parts, but has the detail of the feathers and various parts considerably exaggerated, as the fossil is much less sharply defined and distinct than one might suppose from studying the original cut.

Skull.— The cast containing the anterior portion of the head has been broken away and lost at the line of the pars plana, or perhaps just behind that point. The remaining impression of the skull is present only on the left-hand slab, as on the opposite plate of stone the fossil has been chipped off in an irregular line that passes through the level of the shoulders. On this right-hand slab, however, there is a faint depression in the matrix that outlines the former resting place of the head. In this impression may be traced an indistinct line that indicates a cranium and a forehead that slopes down to a faintly indicated bill, that may or may not have been flattened. It is unfortunate that the actual bone is not present as it would afford important characters.

On the left-hand slab, where the fossil remains, the outline of the cranium is seen to be low and flattened with a low, sloping forehead. A somewhat triangular impression above, that corresponds to the high, distorted concavity of the opposite slabs, represents former feathers or skin; it leads to conjecture regarding a possible crest. The upper and lower outlines of the cranium are marked by broken bits of bone that scribe a distinct but irregular line. Angular impressions in the lower anterior angle of the orbit may indicate sclerotic plates from the eye, and perhaps remains of palatal or ethmoidal elements. The posterior half of the ramus of the lower jaw is fairly distinct; it appears narrow with indication of a foramen. The processus angularis posterior was prolonged slightly beyond the articulation, and then was obliquely truncated. The external ear opening seems to have been small.

Neck.— The curved line of the cervical vertebrae is distinct, but the

impression is so blurred that individual bones may be made out in only a few cases. The total length is moderate as in most small birds.

Shoulder girdle.— The furculum is short and its fork broad, with a slightly projecting, posterior point at the median symphysis as the only certain indication of a hypocleideum. The coracoid, which is badly crushed, apparently was quite strong, with a considerable expansion at the lower end.

Sternum.— The breast bone is very indistinct. A faint outline within the arms of the furculum may indicate the fork of a strong spina externa. The articular points with the lower end of the coracoid are indicated, a slight projection at the lower end of the bone may represent a part of the carina, and an imperfect plate beside it a fragment of the xiphoid extremity. On this latter part there is indicated a single notch. The region is not well enough preserved to show certainly whether one or two notches were present on either side.

Fore-limb.— Both humeri are present though considerably crushed. They appear strong and heavy, with the crista superior shortened so that it does not extend distally beyond the level of the plate that, on the opposite side, forms the boundary of the fossa subtrochanterica.

FIG. 1.— *Palaeospiza bella.* Anterior view of distal end of left humerus, ×4.

FIG. 2.— *Palaeospiza bella.* Posterior view of distal end of right humerus, ×4.

The entire head of the humerus thus appears shortened. The upper end of the shaft is distinctly angled, while the lower portion is rounded as is usual. The ectepicondylar process (Fig. 1) is well developed and is fairly high on the shaft. It is not produced to the extent found in the finches or higher oscines, nor does it seem to be divided at the tip.

Pressure against an underlying bone has forced it backward, but its form is easily evident in spite of this distortion from position. On the opposite side (Fig. 2) the epitrochlea is prominent and is produced distally as a strong process beyond the general level of the outer end of the bone. The ulnar trochlea is narrow but well developed. Its axis is sigmoid, and it extends across to the epitrochlea in a direct line, so that, viewed from above, its distal margin is straight, as in all oscine birds that I have examined. In all the lower Passeriformes, the Eurylaemidae (broad bills), the Mesomyodi (the tracheophones, fly-catchers, cotingas, etc.), and the Pseudoscines (the lyre-bird), the ulnar trochlea has the external margin declivous, sloping down to join the epitrochlea, so that the trochlea projects as a distinct knob. The character seems to be one of importance in separating the higher and the lower Passeriformes.

Above the ulnar trochlea there is evident the depression of the brachialis inferior, with a sharply raised external border, and a flattened surface for the insertion of the pronator brevis and longus. This inner face of the lower end of the humerus is flattened, so that it appears nearly plane.

The radial trochlea is well developed though not large, is slightly concave on its inner face, and at its upper end meets the shaft at an abrupt angle. The intertrochlear sulcus is narrowed.

The ulna is strong, with a fairly prominent olecranal process. Other details are lacking. The radius is well outlined, and, like the ulna, is extraordinarily large and heavy for the size of the bird. The radius, while about as long as the radius in the cedar waxwing, is twice as thick as in that species.

The metacarpus is of the usual passeriform type, with a distinct tuberositas musculis that extends from the second metacarpal across the metacarpal fissure. The tuberculum ulnare appears longer than the tuberculum radiale, but the degree of difference in length between the two may not be made out. The pollex is very faintly indicated. The first phalanx beyond the metacarpal appears relatively shortened, and the second considerably elongated. There is no indication that wing claws were present.

The humerus and the fore-arm are more nearly equal in length than in usual perching birds, as the fore-arm seems only slightly longer than the humerus. The hand too is elongated, and from its indistinct impression appears nearly, and perhaps actually, as long as the fore-arm.

The outstanding features of the wing are the shortened fore-arm,

the elongated distal phalanx of the second digit, and the remarkable strength of radius and ulna.

Ribs.— A few of the posterior ribs show as hair lines below the sternum at one side. Apparently only the sternal segments are preserved.

Pelvis.— The pelvic region is too indistinct to offer details of importance. The sacrum is outlined with some definiteness but is considerably crushed. There is faint presentation of the ilium.

Posterior limb.— The femur, which is shown in outline on the left half of the fossil, seems to have been comparatively long and strong. The outer face, apparently the one presented, was straight as there is no indication of axial flexure. The tibio-tarsus appears of moderate length in comparison with the femur. It was fairly strong, but is so crushed that the terminal processes are only faintly evident. The tarsus seems to have been remarkably small and slender. There is some indication, particularly on the left-hand slab, that the acrotarsium was smooth and was of the acutiplantar form usual in typical oscine birds (except the Alaudidae, where it is latiplantar). No scutellation is actually evident on the anterior face, though there is faint indication that the tarsal sheath of this portion may have been divided. Both tarsi are somewhat broken at the lower end which gives them the appearance of being slightly less in length than is really the case.

The toes, four in number, comparatively long with long, slender claws, are arranged with three projecting toward the front and one behind, in the typical passeriform manner. The third toe, the middle anterior one, is slightly longer than the others, while the second and fourth on either side are apparently about equal in length. The hind toe, while long, is decidedly shorter than the other three.

Feathers.— On one or the other of the halves of the cast wing and tail feathers, with a few on flank, neck, and breast, are represented by a blackish discoloration, that in the case of the larger feathers is lined by impressions made by the heavy shafts. The tail seems to have been broad and perhaps rounded. The two median rectrices project eight millimeters beyond the others; the lateral feathers, clearly visible on the right-hand side, decrease gradually in length toward the outside. The shafts of six feathers are faintly impressed on this right side, indicating a tail of at least twelve rectrices.

The wings are folded in against the body and cannot be seen distinctly. They are long, as in their folded condition the distal end extends well past the base of the tail. It appears that they were of fairly broad area; details of their structure may not be determined.

Measurements.— As most of the bones in *Palaeospiza bella* are somewhat crushed, or even broken, lengths of the various parts may be determined only approximately. All measurements given below have been taken carefully by means of dividers.

Length of specimen from point of shoulder to approximate end of pope's nose	66.5 mm.
Length of furculum	14.5 "
" " humerus	23.4 "
Breadth of humerus at distal end	5.5 "
" " shaft of humerus near center	3.0 "
Length of ulna	22.0 "
" " hand	24.5 "
" " metacarpus	12.6 "
" " distal phalanx of second digit	6.0 "
" " femur	18.0 "
" " tibio-tarsus	27.0 "
" " tarso-metatarsus	17.5 "
" " middle toe and claw (measured in two segments)	15.6 "
" " impression of longest rectrix	58.5 "
Approximate length of wing	80.0 "

Systematic Position.

Allocation of *Palaeospiza bella* in our scheme of avian classification is difficult, as the greater part of the head is missing, and the fossil, though handsome to look upon, lacks definite impressions of many of the points used in deciding relationship. It appears that *Palaeospiza bella* is not directly related to any of our modern groups, but must stand in a separate category to be known as the family

Palaeospizidae.

Type.— *Palaeospiza bella* Allen.

Diagnosis.— Bones of the wing strong and heavy, with humerus only slightly shorter than fore-arm and hand elongated; head of humerus shortened, distal end with ulnar trochlea not produced as a knob beyond level of epitrochlea (oscinine in form); anterior face of lower end of humerus much flattened; ectepicondylar process relatively high on shaft, distal phalanx of second digit elongated, radius and ulna very strong; tarsus small and slender, toes long, with long slender claws; third toe longest, second and fourth about equal, the first somewhat shorter than the other three.

Relationships.— In its large wings and small feet *Palaeospiza bella* suggests some of the flycatchers or cotingas. It seems particularly to have had very long wings, longer than in the average perching bird. In size it appears about equal to the cedar waxwing (*Bombycilla cedrorum*). The form of the foot, with the general sum of the appearance of the bird, indicate that Palaeospiza is a member of the great order of Passeriformes. Further, the form of the ulnar trochlea of the humerus definitely places it in the superfamily Oscines as defined by Ridgway. It is undoubtedly low in position in that group; and it has been indicated that it gives certain suggestions of approach to some members of the superfamily Mesomyodi.

The family Palaeospizidae, therefore, may be placed in the Oscines immediately above the Alaudidae, which family in form of the tarsus differs from all other Passeriformes, and is located at the base of the oscinine group. Palaeospiza has no direct relationship to the larks, but rather occupies a somewhat connecting position between the Mesomyodi and the acutiplantar Oscines.

The Palaeospizidae at present includes a single species, *Palaeospiza bella*.

The Status of Palaeospiza hatcheri Shufeldt.

In connection with a study of *Palaeospiza bella* Allen it has been necessary to examine a second fossil, one named by Dr. Shufeldt (Bull. Amer. mus. nat. hist., 4 August, 1913, **32**, p. 301, pl. 55, fig. 28) *Palaeospiza hatcheri*, secured near Long Island, Kansas, from beds of doubtful position sometimes called lower Pliocene, but at present usually considered Miocene. In the original description this form was characterized as follows:— "This is the superior mandible of a small finch . . . and it would be difficult to distinguish the same from the same part of the skull in many a small existing species of that group, the size of a *Junco* for example, or a *Spinus*. The species may, quite possibly, still be in existence or its genus may; in any event, this material is not sufficiently extensive for a scientific reference. I have not seen the material upon which Allen based his *Palaeospiza* from the Amyzon Shales of Colorado (Eocene ?). Should it be found to belong in that genus, it may, for the sake of designation and record, be subsequently known as *P. hatcheri* for its discoverer. . . ."

The type of *Palaeospiza hatcheri* (U. S. N. M. Cat. 6,647) is an entire upper mandible forward of its junctions with the frontal and the anterior end of the jugals (Fig. 3, 4). It was secured with broken

fragments of other small vertebrates by J. B. Hatcher in 1884. It requires but a glance to determine that this specimen comes from a typical finch (Fringillidae), and as such has only remote connection with the type of the genus Palaeospiza. Though imperfect, the type of *hatcheri* is sufficiently complete to exhibit pertinent characters. On careful comparison it is found to differ so from modern finches as to necessitate the erection for it of a distinct group which may be called

Palaeostruthus, gen. nov.

Characters.— Similar to Pipilo Vieillot (Analyse, 1816, p. 32. *Type.*— *Fringilla erythrophthalma* Linné), but premaxilla more acute at point, lateral margins more concave; nasal process of premaxilla of uniform width throughout, not expanding in anterior half toward its union with premaxilla; maxilla not produced posteriorly behind union with maxillary process of nasal; maxillary process of nasal not decidedly expanded at lower end where it joins maxilla.

Type.— *Palaeospiza hatcheri* Shufeldt, which will now stand as *Palaeostruthus hatcheri* (Shufeldt).

Fig. 3. — Palaeostruthus hatcheri. Type. Dorsal view. ×2.

Fig. 4. — Palaeostruthus hatcheri. Lateral view. ×2.

Remarks.

Somewhat extended comparisons of *Palaeostruthus hatcheri* with skulls of a large number of species of finches from the New and Old Worlds have placed it in the supergeneric group termed by Ridgway the Zonotrichiae, a group that contains the towhees, juncos, white-throats, song sparrows, chipping sparrows, and the host of allied species that today comprise a majority of our native sparrows.

In outline the premaxilla of *hatcheri* is very near to *Ammodramus savannarum*, as it has the same acute point, concavity of the lateral

margins, and pronounced posterior broadening of that species. The arrangement of the maxillary in Palaeostruthus is, however, distinctly different, and places it in another group. It seems allied to Pipilo, particularly to the forms in which the males are largely black and white differing from these in the points outlined in the diagnosis. In size *Palaeostruthus hatcheri* is smaller as it seems to have the approximate dimensions of the green-tailed towhee, *Oberholseria chlorura*.

It will stand in the Zonotrichiae adjacent to the genus Pipilo.

Following are pertinent measurements of the type of *Palaeostruthus hatcheri*:—

Total length from tip of premaxilla to posterior margin of nasal opening	10.0 mm.
Greatest breadth through maxillae	6.3 "
Greatest horizontal depth from bridge of culmen to maxilla	3.5 "
Length of external narial opening	4.0 "
Depth of external narial opening	2.0 "

EXPLANATION OF THE PLATES.

PLATE 1.

PLATE 1.

Palaeospiza bella. View of portion of type specimen with part of head, life size.

PLATE 2.

PLATE 2.

Palaeospiza bella. Same as Plate 1, retouched to bring out detail of bones, life size.

PLATE 3.

PLATE 3.

Palaeospiza bella. View of half of type opposite to that shown in Plate 1, life size.

PLATE 4.

PLATE 4.

Palaeospiza bella. Same as Plate **3**, retouched to bring out detail of bones, life size.

No. 3.— *The Henry Bryant Types of Birds.*

By Outram Bangs and Thomas E. Penard.

After the death of Dr. Henry Bryant, in 1867, his collection of birds remained in the possession of his son, Dr. W. S. Bryant, and finally was presented by Dr. Bryant's heirs to the Museum of Comparative Zoölogy. In the meantime, Mrs. Henry Bryant had given some specimens to the U. S. N. M. and to several foreign institutions, and in that way a number of the Bryant types passed into other hands.

The birds collected by Robert Swift and George Latimer in Porto Rico, and described by Dr. Bryant, originally went to the U. S. N. M., but subsequently many were either donated to or exchanged with home and foreign museums or collectors, and among that number were several of the types, including those of *Todus hypochondriacus*, *Psittacus collarius bahamensis*, *Saurothera vieillotii rufescens*, *Turdus ardosiaceus portoricensis*, *Tyrannus antillarum*, *Mimus polyglottus portoricensis*, and *Tanagra dominicensis*. Fortunately two of these, *Tyrannus antillarum* and *Tanagra dominicensis*, became the property of Dr. Bryant and are now in the collection of the M. C. Z.

Altogether Dr. Bryant proposed six new genera and subgenera, described twenty-eight new species and subspecies, and was responsible for one *nomen nudum*.

An account of Dr. Bryant's life and scientific career, prepared by a Committee consisting of S. L. Abbot, J. C. White, and J. E. Cabot, appointed at the meeting of the Boston Society of Natural History, on February 20, 1867, of which Society Dr. Bryant was an active member, was published in the Proceedings of that Society (Proc. Boston soc. nat. hist., 1867, **11**, p. 205–215) shortly after his death which took place at Araceibo, Porto Rico, in February, 1867, while on a collecting trip.

During his life Dr. Bryant made a number of expeditions for scientific research, visiting California, Grand Manan, Florida (several times), Bahamas (several trips), Canada, and Labrador, North Carolina, Cuba, Jamaica, and Porto Rico; as a result of these he published a number of papers dealing with the birds he collected or observed.

He made many donations of natural history specimens to the Boston Society of Natural History, a partial list of which has been published in the report of the committee referred to above. The most important of these was the magnificent Lafresnaye collection of birds, containing

nearly nine thousand specimens, which he had purchased in France upon the death of the noted French ornithologist. This, one of the finest collections of that time, brought to this country not only most of the types of the species (mostly American) described by Lafresnaye, but also those of many other naturalists whose types had found their way into Lafresnaye's possession. This valuable collection has since been transferred to the M. C. Z.

The Committee's report also contained a list of communications and papers read by Bryant at the meetings of the Society.. Several minor articles or communications having escaped the notice of that Committee, we have included in this paper a list of his ornithological writings, in so far as these have come within our ken in our search for Bryant material.

List of the ornithological writings of Henry Bryant.

[Report on a volume of the Naturalist's library, on gallinaceous birds].
Proc. Boston soc. nat. hist., 1841, **1**, p. 19.

[Report on a parrot presented by Mr. Teschemacher to the Boston Society of Natural History].
Proc. Boston soc. nat. hist., 1842, **1**, p. 60.

Premier essai d'une détermination nouvelle de ce qu'on a nommé jusqu'à présent corps strié chez les oiseaux (Extrait d'une Note de MM. Bryant et Pappenheim).
Compt. rend. Acad. sci. Paris, 1848, **26**, p. 276–278.

[On the Sandhill Crane — the non-identity of *Grus canadensis* and *Grus mexicana*].
Proc. Boston soc. nat. hist., 1853–1854, **4**, p. 303–307.

[Occurrence of the Yellow-crowned Warbler and Hemlock Warbler at Cohasset, Mass. in the month of January].
Proc. Boston soc. nat. hist., 1855, **5**, p. 142.

A list of birds observed at Grand Manan and at Yarmouth, N. S. from June 16 to July 8, 1856.
Proc. Boston soc. nat. hist., 1857, **6**, p. 114–123.

[Note on Arctic birds: causes of migration].
Proc. Boston soc. nat. hist., 1857, **6**, p. 124.

[On a supposed new species of turkey].
Proc. Boston soc. nat. hist., 1857, **6**, p. 158, 159.

[Remarks on some birds presented to the Boston Society of Natural History by the Royal Victoria Society of Melbourne, Australia].
Proc. Boston soc. nat. hist., 1857, **6**, p. 169, 170.

[Early appearance of migratory birds].
Proc. Boston soc. nat. hist., 1857, **6**, p. 170.

[On some birds observed in East Florida, south of St. Augustine].
Proc. Boston soc. nat. hist., 1859, **7**, p. 5–21.

A list of birds seen at the Bahamas, from Jan. 20th to May 4th, 1859, with descriptions of new or little known species.
Proc. Boston soc. nat. hist., 1859, **7**, p. 102–134.

[Note on *Turdus minimus* Lafresnaye and a new Vireo. *Vireo bogotensis*].
Proc. Boston soc. nat. hist., 1860, **7**, p. 226, 227.

[Remarks on *Trochilus bahamensis* Bryant].
Proc. Boston soc. nat. hist., 1860, **7**, p. 317.

Remarks on some of the birds that breed in the Gulf of St. Lawrence.
Proc. Boston soc. nat. hist., 1861, **8**, p. 65–75.

Remarks on the variations of plumage in *Buteo borealis*, Auct., and *Buteo harlani*, Aud.?
Proc. Boston soc. nat. hist., 1861, **8**, p. 107–119.

Monograph of the genus Catarractes, Moehring.
Proc. Boston soc. nat. hist., 1861, **8**, p. 134–144.

Description of two birds from the Bahama Islands, hitherto undescribed.
Proc. Boston soc. nat. hist., 1864, **9**, p. 279, 280.

Description of a new variety of Parus from Yarmouth, Nova Scotia.
Proc. Boston soc. nat. hist., 1865, **9**, p. 368, 369.

Remarks on the genus Galeoscoptes Cabanis, with the characters of two new genera, and a description of *Turdus plumbeus* Lin.
Proc. Boston soc. nat. hist., 1865, **9**, p. 369–372.

Remarks on the type of *Buteo insignatus* Cassin.
Proc. Boston soc. nat. hist., 1865, **10**, p. 90, 91.

Remarks on *Sphyropicus varius* Linn.
Proc. Boston soc. nat. hist., 1865, **10**, p. 91–93.

A list of birds from Porto Rico presented to the Smithsonian Institution, by Messrs. Swift and George Latimer, with descriptions of new species or varieties.
Proc. Boston soc. nat. hist., 1866, **10**, p. 248–257.

Additions to a list of birds seen at the Bahamas.
Proc. Boston soc. nat. hist., 1867, **11**, p. 63–70.

A list of the birds of Santo Domingo, with descriptions of some new species or varieties.
Proc. Boston soc. nat. hist., 1867, **11**, p. 89–98.

New genera and subgenera proposed by Henry Bryant.

Kalochelidon Bryant (Proc. Boston soc. nat. hist., 1867, **11**, p. 95) = Lamprochelidon Ridgway. Type.—*Hirundo euchrysea dominicensis* Bryant (not *Hirundo dominicensis* Gmelin) = *Lamprochelidon sclateri* (Cory).

Skotiomimus Bryant (Proc. Boston soc. nat. hist., 1867, **11**, p. 68) = Mimus Boie. Type.— *Mimus bahamensis* Bryant.

Leucomimus Bryant (Proc. Boston soc. nat. hist., 1867, **11**, p. 68) = Mimus Boie. Type.— *Mimus polyglottus bahamensis* Bryant.

Mimokitta Bryant (Proc. Boston soc. nat. hist., 1865, **9**, p. 370) = Mimocichla Sclater. Type.— *Turdus plumbeus* Linné.

Spizampelis Bryant (Proc. Boston soc. nat. hist., 1866, **10**, p. 253) = Spindalis Jardine and Selby. Type.— *Tanagra pretrei* Lesson.

Shizampelis Bryant (Proc. Boston soc. nat. hist., 1867, **11**, p. 68) is a typographical error.

Loximitris Bryant (Proc. Boston soc. nat. hist., 1867, **11**, p. 93). Type.— *Chrysomitris dominicensis* Bryant.

Species and subspecies described by Henry Bryant.

The following species and subspecies were described as new by Henry Bryant. Those marked with an asterisk (*) are represented by type or cotype in the M. C. Z.

Catarractes californicus Bryant (Proc. Boston soc. nat. hist., 1861, **8**, p. 142. Farrellones Islands, near San Francisco, California) = *Uria troille californica* (Bryant). Type in U. S. N. M.

* *Sula elegans* Bryant = *Sula dactylatra dactylatra* Lesson.

Todus hypochondriacus Bryant (Proc. Boston soc. nat. hist., 1866, **10**, p. 250. Porto Rico) = *Todus mexicanus* Lesson. Type formerly in U. S. N. M., 36,450, designated by Bryant.

Psittacus collarius bahamensis Bryant (Proc. Boston soc. nat. hist., 1867, **11**, p. 65. Fortune Island, Auckland Island, and Inagua) = *Amazona leucocephala bahamensis* (Bryant). Type formerly in U. S. N. M.

* *Trochilus bahamensis* Bryant = *Nesophlox evelynae* (Bourcier).

* *Saurothera bahamensis* Bryant = *Saurothera bahamensis bahamensis* Bryant.

Saurothera vieillotii rufescens Bryant (Proc. Boston soc. nat. hist., 1866, **10**, p. 256. Porto Rico) = *Saurothera vieilloti* Bonaparte. Type formerly in U. S. N. M., 36,440, designated by Bryant; now in Mombuspo Museum, Tokio, Japan.

* *Pitangus bahamensis* Bryant = *Tolmarchus bahamensis* (Bryant).

* *Empidonax bahamensis* Bryant = *Blacicus bahamensis* (Bryant).

Tyrannula carriboca hispaniolensis Bryant (Proc. Boston soc. nat. hist., 1867, **11**, p. 91. Santo Domingo) = *Blacicus hispaniolensis* (Bryant). Type in U. S. N. M., 42,474, designated by Bryant.

Tyrannula stolida dominicensis Bryant (Proc. Boston soc. nat. hist., 1867, **11**, p. 90. Santo Domingo) = *Myiarchus dominicensis* (Bryant). Type in U. S. N. M., 41,825, designated by Bryant.

* *Tyrannula stolida lucaysiensis* Bryant = *Myiarchus sacrae lucaysiensis* (Bryant).

Tyrannula bahamensis Bryant (Proc. Boston soc. nat. hist., 1867, **11**, p. 90). Probably a *lapsus* for *Tyrannula lucaysiensis* Bryant = *Myiarchus sacrae lucaysiensis* (Bryant).

* *Tyrannus antillarum* Bryant = *Myiarchus antillarum* (Bryant).

* *Hirundo cyanoviridis* Bryant = *Callichelidon cyanoviridis* (Bryant).

* *Mimus polyglottus bahamensis* Bryant = *Mimus polyglottos elegans* Sharpe.

Mimus cubanensis Bryant (Proc. Boston soc. nat. hist., 1866, **10** p. 251; 1867, **11**, p. 68, *nomen nudum*).

Mimus polyglottus portoricensis Bryant (Proc. Boston soc. nat. hist., 1866, **10**, p. 251. Porto Rico) = *Mimus polyglottos orpheus* (Linné). Type formerly in U. S. N. M., 33,476, designated by Bryant.

* *Mimus bahamensis* Bryant = *Mimus gundlachii bahamensis* Bryant.

Turdus ardosiaceus portoricensis Bryant (Proc. Boston soc. nat. hist., 1867, **11**, p. 93, Porto Rico) = *Mimocichla ardosiacea portoricensis* (Bryant). Location of type unknown.

* *Vireo bogotensis* Bryant = *Vireo virescens* Vieillot.

* *Laniovireo crassirostris* Bryant = *Vireo crassirostris crassirostris* (Bryant).

* *Parus hudsonicus littoralis* Bryant = *Penthestes hudsonicus littoralis* (Bryant).

* *Geothlypis rostratus* Bryant = *Geothlypis rostrata* Bryant.

Chrysomitris dominicensis Bryant (Proc. Boston soc. nat. hist., 1867, **11**, p. 93. Port au Prince, Haiti) = *Loximitris dominicensis* (Bryant). Type in U. S. N. M., 42,464, designated by Bryant.

* *Tanagra dominicensis* Bryant = *Spindalis dominicensis* (Bryant).

Tanagra portoricensis Bryant (Proc. Boston soc. nat. hist., 1866, **10**, p. 252. Porto Rico) = *Spindalis portoricensis* (Bryant). Type formerly in U. S. N. M., 36,502, designated by Bryant.

Certhiola flaveola portoricensis Bryant (Proc. Boston soc. nat. hist., 1866, **10**, p. 252. Porto Rico) = *Coereba portoricensis* (Bryant). Type in U. S. N. M.

* *Icterus dominicensis portoricensis* Bryant = *Icterus portoricensis* Bryant.

Bryant types in the Museum of Comparative Zoölogy.

Sula dactylatra dactylatra Lesson.

Sula dactylatra Lesson, Traité d'ornith., 1831, p. 601. (Ascension).
Sula elegans Bryant, Proc. Boston soc. nat. hist., 1859, **7**, p. 125. (Santo Domingo Key, Bahamas).

Cotype.— M. C. Z., 42,939, ♂. Santo Domingo Key, Bahamas, April 10.

Cotype.— M. C. Z., 42,940, ♀. Santo Domingo Key, Bahamas, April 10.

Cotype.— M. C. Z., 42,941, ♀. Santo Domingo Key, Bahamas, April 10.

Remarks.— If the breeding Bahama bird should prove to be different from that of Ascension, as it well may be, then Bryant's name becomes available for it.

Nesophlox evelynae (Bourcier).

Trochilus evelynae Bourcier, Proc. Zool. soc. London, 1847, p. 44. (Nassau, New Providence Island, Bahamas; coll. M. Loddiges).

Trochilus bahamensis Bryant, Proc. Boston soc. nat. hist., 1859, **7**, p. 106. (Nassau, New Providence Island, Bahamas).

Cotype.— M. C. Z., 46,812, ♂. Nassau, Bahamas, March 2, 1859.

Cotype.— M. C. Z., 46,813, ♀. Nassau, Bahamas, February 15, 1859.

Remarks.— Bryant collected seven specimens, four males and three females, all of which are, of course, cotypes. The M. C. Z. now has one male and one female. Other cotypes are in the U. S. N. M.

Saurothera bahamensis bahamensis Bryant.

Saurothera bahamensis Bryant, Proc. Boston soc. nat. hist., 1864, **9**, p. 280. (New Providence Island, Bahamas).

Cotype.— M. C. Z., 45,972, ♀. Nassau, Bahamas, May, 1859.

Cotype.— M. C. Z., 45,971, ♂. Nassau, Bahamas, April, 1859.

Tolmarchus bahamensis (Bryant).

Pitangus bahamensis Bryant, Proc. Boston soc. nat. hist., 1864, **9**, p. 279 (Bahamas).

Type.— M. C. Z., 46,714. Nassau, Bahamas, April 20, 1857.

Remarks.— Apparently Bryant took but a single specimen on his first trip, this being the only one listed in his catalogue. But there is another specimen, M. C. Z., 74,589, with a substituted label, probably collected on Bryant's second trip to the Bahamas.

Blacicus bahamensis (Bryant).

Empidonax bahamensis Bryant, Proc. Boston soc. nat. hist., 1859, **7**, p. 109. (Bahamas).

Cotype.— M. C. Z., 46,715, ♂. Nassau, Bahamas.

Cotype.— M. C. Z., 46,716, ♂. Nassau, Bahamas.

Remarks.— Bryant mentions having seen three specimens, but only two males are listed in the catalogue of his collection.

Myiarchus sacrae lucaysiensis (Bryant).

Tyrannula stolida (var. *lucaysiensis*) Bryant, Proc. Boston soc. nat. hist., 1867, **11**, p. 66. (Inagua and New Providence Islands, Bahamas).

?Tyrannula bahamensis Bryant, Proc. Boston soc. nat. hist., 1867, **11**, p. 90, in text under *Tyrannula stolida dominicensis* (no locality designated).

Cotype.— M. C. Z., 74,553. Bahamas.

Remarks.— Bryant mentions having collected several specimens and gives measurements of an adult male. We do not know where the other cotypes now are.

In the second citation Bryant apparently meant to refer to his *Tyrannula lucaysiensis* and inadvertently used the name *bahamensis*.

Myiarchus antillarum (Bryant).

Tyrannus antillarum Bryant, Proc. Boston soc. nat. hist., 1866, **10**, p. 249. (Porto Rico).

Type.— M. C. Z., 46,885. Porto Rico, winter. Robert Swift. Formerly U. S. N. M., 36,459.

Remarks.— This is the specimen designated by number in the original description and is thus the holotype.

Callichelidon cyaneoviridis (Bryant).

Hirundo cyaneoviridis Bryant, Proc. Boston soc. nat. hist., 1859, **7**, p. 111. (Nassau, New Providence Island, Bahamas).

Cotype.— M. C. Z., 46,838, ♂. Nassau, Bahamas.

Cotype.— M. C. Z., 46,840, ♂. Nassau, Bahamas, April 17.

Cotype.— M. C. Z., 46,841, ♂. Nassau, Bahamas, April 12.

Remarks.— Bryant mentions seeing this species only on the first mile of the road leading to the west end of the island; thirty or forty, he says, could be seen at almost all times. He adds that he did not kill any specimens after 28 April.

The catalogue of his collection lists only five specimens of which four are now at the M. C. Z. The fifth specimen, a female collected 1 April, formerly M. C. Z., 46,837, is now in the Thayer museum, Lancaster, Mass. This must be the female described. The U. S. N. M. also has at least one cotype, and Academy of Natural Sciences of Philadelphia has another, 15,639, presented by Dr. Bryant in 1860.

One of the four specimens listed in Bryant's catalogue, another male, M. C. Z., 46,839, bears on its label the date May 1, and must thus have been collected when Bryant visited the island in 1866.

Mimus polyglottos elegans Sharpe.

Mimus elegans Sharpe, Cat. birds Brit. mus., 1881, **6**, p. 339. (Inagua, Bahamas).

Mimus polyglottus (var. *bahamensis* "?") Bryant, Proc. Boston soc. nat. hist., 1867, **11**, p. 68. (Inagua, Bahamas), not *Mimus bahamensis* Bryant, Proc. Boston soc. nat. hist., 1859, **7**, p. 114.

Cotype.— M. C. Z., 72,289. Inagua.

Remarks.— According to Sharpe (Cat. birds Brit. mus., 1881, **6**, p. 340) there is another specimen collected by Bryant in the collection of the British Museum. This specimen must also be considered a cotype of Bryant's *Mimus polyglottus bahamensis*. We do not know of the existence of any other specimens of this species of Bryant's collecting.

Mimus gundlachii bahamensis Bryant.

Mimus bahamensis Bryant, Proc. Boston soc. nat. hist., 1859, **7**, p. 114. (Berry Islands, Bahamas).

Cotype.— M. C. Z., 46,870, ♂. Berry Islands, Bahamas, April 20.

Cotype.— M. C. Z., 46,871, ♀. Berry Islands, Bahamas, April 14, 1858.

Remarks.— There is also in the M. C. Z. a specimen from Inagua, collected by Bryant, which cannot be considered a cotype. Bryant did not visit that island in 1859.

We doubt whether the form *bahamensis* can be kept distinct from *gundlachii*, even as a subspecies.

Vireo virescens Vieillot.

Vireo virescens Vieillot, Ois. Amer. sept., 1807, **1**, p. 84, pl. 53 (no type locality stated, we designate Pennsylvania).

Vireo bogotensis Bryant, Proc. Boston soc. nat. hist., 1860, **7**, p. 227. (Bogota).

Type.— M. C. Z., 47,159. Bogota, N. G.

Remarks.— *Muscicapa olivacea* Linné, Syst. nat., 1766, **1**, p. 327, based on the Olive-coloured Flycatcher of Edwards, Gleanings nat. hist., 1758, p. 93, pl. 253, cannot be used for the Red-eyed Vireo,

because Edwards figured and described the Black-whiskered Vireo from Jamaica. Vieillot's *Vireo virescens* appears to be the next name in synonymy available for this bird.

The Black-whiskered Vireo, on the other hand, must be known as *Vireo olivaceus* (Linné), because *Motacilla calidris* Linné, Syst. nat., 1758, **1**, p. 184, based on Edwards's American Nightingale, Nat. hist. birds, 1750, **3**, p. 121, pl. 121, is unrecognizable. The plate certainly does not represent a Vireo. The colouration is wholly different, and the bill which Edwards said he drew with great care, has no end hook and is shaped like that of a mniotiltid, almost exactly like that of Swainson's Warbler, *Helinaia swainsonii* Audubon.

The forms of the Black-whiskered Vireo, therefore, should be known as:

Vireo olivaceus olivaceus (Linné).
Vireo olivaceus barbadensis Ridgway.
Vireo olivaceus barbatulus Cabanis.
Vireo olivaceus grandior (Ridgway).
Vireo olivaceus canescens (Cory).

Vireo crassirostris crassirostris Bryant.

Laniovireo crassirostris Bryant, Proc. Boston soc. nat. hist., 1859, **7**, p. 112. (New Providence Island, Bahamas).

Cotype.— M. C. Z., 46,779, ♂. Nassau, Bahamas, April 10; the yellow phase (*flavescens*).

Cotype.— M. C. Z., 46,780, ♂. Nassau, Bahamas, March 20; the gray phase.

Remarks.— Bryant states that three specimens were all he obtained. Two, the cotypes mentioned above, are listed in his catalogue. The third is in the collection of the U. S. N. M.

There is another specimen, M. C. Z., 72,562, without original label, but bearing the locality Bahamas. It is in much less worn plumage than the others and is a very yellow example (phase, *flavescens*). We suspect it came from Inagua.

Pentiiestes hudsonicus littoralis (Bryant).

Parus hudsonicus, var. *littoralis* Bryant, Proc. Boston soc. nat. hist., 1865, **9**, p. 368. (Yarmouth, Nova Scotia).

Cotype.— M. C. Z., 46,976, ♂. Yarmouth, N. S., July 7.
Cotype.— M. C. Z., 46,977, ♀. Yarmouth, N. S., July 7.

Cotype.— M. C. Z., 46,978, ♂. Yarmouth, N. S., July 7.
Cotype.— M. C. Z., 46,979, Y. Yarmouth, N. S., July 7.
Cotype.— M. C. Z., 46,980, Y. Yarmouth, N. S., July 7.

Geothlypis rostrata Bryant.

Geothlypis rostratus Bryant, Proc. Boston soc. nat. hist., 1867, **11**, p. 67. (Nassau, New Providence Island, Bahamas).

Cotype.— M. C. Z., 73,316. Bahamas.

Remarks.— Bryant mentions three specimens, all males. Ridgway (Birds of North and Middle America, 1902, **2**, p. 675) claims one of the cotypes for the U. S. N. M. We do not know where the third specimen is.

Spindalis dominicensis (Bryant).

Tanagra dominicensis Bryant, Proc. Boston soc. nat. hist., 1867, **11**, p. 92. (Santo Domingo and Port au Prince, Haiti).

Cotype.— M. C. Z., 73,945. Port au Prince, June 10, 1866. A. C. Younglove. Formerly U. S. N. M., 42,448.

Remarks.— Ridgway claims no cotypes of this species for the U. S. N. M., and we do not know where the other cotypes now are. The one listed above was in Dr. Bryant's collection when it came to the M. C. Z.

The description of *Tanagra multicolor* Vieillot, Enc. meth., 1823, **2**, p. 775 (Florida, Bahamas, and Santo Domingo) is composite, applying for the most part to the Black-backed *Spindalis zena* (Linné). We cannot accept the name *Spindalis multicolor* (Vieillot), on that basis, because the only species with a black back in the genus is *zena*. For this very reason Bryant, as stated by himself, discarded Vieillot's appellation and named the species *dominicensis*.

Icterus portoricensis Bryant.

Icterus dominicensis var. *portoricensis* Bryant, Proc. Boston soc. nat. hist., 1866, **10**, p. 254. (Porto Rico).

Type.— M. C. Z., 46,539, adult. Porto Rico, winter, Robert Swift.

Remarks.— This specimen was in the Bryant collection when it came to the M. C. Z. Bryant (*l. c.*) also mentions and describes the plumage of the young bird.

JUL 31 1925

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LXVII. No. 4.

DIAGNOSES OF NEW AMERICAN ARACHNIDA.

By Ralph V. Chamberlin.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
July, 1925.

No. 4.— *Diagnoses of new American Arachnida.*

By Ralph V. Chamberlin.

The new arachnids in several collections submitted for identification are here diagnosed to render their names available for early use in connection with the ecological and other studies which led to the making of the collections. Of these collections mention may be made specially of one by Prof. W. C. Allee on Barro Colorado Island, Canal Zone, of one by James Zetek made in the course of work on the fauna of termite nests, also in the Canal Zone, and of one consisting of specimens taken from the stomachs of toads and the crops of birds in various parts of North America in the course of studies on food-habits made by the U. S. Biological Survey at Washington. The types of these new species are in the Museum of Comparative Zoölogy, Cambridge.

ARANEINA.

Ctenizidae.

Pachylomerus eremus, sp. nov.

♀. Carapace and legs dusky brown, paler over a median area in front of the strongly procurved thoracic impression. Sternum, coxae of legs beneath, and the tarsi yellowish. Abdomen with a slightly purplish cast, the spinnerets light brown. Eyes on a slightly elevated tubercle. Area of median eyes wider behind than in front in the ratio 13:10. Anterior median eyes with diameter not half that of an anterior lateral. Inner margin of furrow of chelicera with four teeth, the outer with seven. Labium in type with the teeth in three series. Endites with teeth over entire length, those toward distal end smaller than the basal ones. Anterior tibiae and tarsi with a band of several series of spines along each side. Patellae I and II with an obtuse protuberance on caudal side, and patella I with a single spine at distal end on anterior side. Patella III with several short spines on anterior side of which the distal ones are larger than the others. Tibia III with a few small spines across distal end above and several stouter ones at distal end on caudal side. Metatarsus III with spines only on distal half above.

Length, 8.5 mm.
Type.— M. C. Z. 1,261.
Locality.— Barro Colorado Island. One female.

Pachylomerus oaxacanus, sp. nov.

♀. Original color altered in preservation. Apparently the cephalothorax and legs were light brown and the abdomen dark gray or blackish. Palpi flattened, with spines along edges. Anterior legs with the several bands of spines along sides as usual. Patella III with a row of spines across distal end above and several spines back of this row. Tibia III with many spines above and on anterior side distad of the depression. Entire upper surface of metatarsus III covered with spines. Spines along anterior side of metatarsus III and ventrally at distal end. Rastellum carried forward on a prominent process above base of claw. Endites with a small triangular patch of stout spinules at proximal end, the spinules elsewhere sparse and much weaker. In the type there are eight spinules on the labium.

♂. Tibia of palpus swollen convexly below, the greatest thickness equal to half the length, greater than that of femur in about ratio 22:13. Stylus of bulb rather short, proximally stout, slightly curved at distal end.

Length of about 9 mm.

Type.— M. C. Z. 1,262.

Locality.— Mexico: Oaxaca. One male and one female from the stomach of a toad.

Dysderidae.

Ariadna jaliscoensis, sp. nov.

♀. Carapace chestnut, dusky on sides anteriorly. Sternum and legs also chestnut; the tibiae, metatarsi, and tarsi of first pair with tegument darkened; femur, patella, tibia, and metatarsus in particular clothed with numerous long hairs. The second legs similarly but less densely clothed. Abdomen dark gray above, without markings, paler beneath. Median eyes circular, contiguous, and forming with the posterior laterals a straight line; separated from the laterals by their diameter. Tibia I with four pairs of spines beneath, metatarsus I with nine pairs. Tibia II with four spines under the posterior border and two under the anterior border paired with the most distal ones of posterior row; two spines on anterior face caudad of the middle. Tibia III with two seriate spines beneath.

Length, 12 mm.

Type.— M. C. Z. 1,263.

Locality.— Mexico: S. W. Jalisco, Hacienda San Marcos, P. H. Goldsmith. 11–17 July, 1905. One female.

Gnaphosidae.

Gnaphosa peon, sp. nov.

♀. Carapace and legs dull yellow. Sternum lighter yellow. Abdomen dark gray at sides and above or the dorsum somewhat lighter, in part of an orange tinge. Venter lighter. Posterior median eyes oblong or subelliptic, oblique to each other, separated by half their longest diameter, about once and a third that diameter from the laterals. Lateral eyes on each side separated by slightly more than their diameter. Anterior row of eyes decidedly procurved; medians with their diameter five sixths that of the laterals. Clypeus equal in height to the diameter of an anterior lateral eye. Tibia I unarmed beneath. Tibia II with a single ventral spine, this at distal end. Metatarsi I and II each with two pairs of spines beneath. Tibia III with a median dorsal spine above.

Length, 6 mm.
Type.— M. C. Z. 1,264.
Locality.— Mexico: Vera Cruz. Two females.

Geodrassus yavapainus, sp. nov.

♀. Carapace and sternum yellowish brown. Legs yellow. Abdomen dark gray above, lighter beneath as usual. The posterior median eyes oblique, less than half their longer diameter apart, once and a half that diameter from the laterals. Lateral eyes about once and a fourth the diameter of the posterior one apart. Tibia I with one long spine beneath a little distad of middle. The epigynal area is proportionately wider than in *phanus* and much more so than in *auriculoides;* having much the shape of that of the former species but with foveolae more strictly transverse.

Length, 7.2 mm. Length of cephalothorax, 4.1 mm.; of tibia + patella IV, 4.1 mm.
Type.— M. C. Z. 1,266.
Locality.— Arizona: Yavapai Co. One female from stomach of toad.

Zodariidae.

Naibena, gen. nov.

Cephalothorax convex, highest near middle, the pars cephalica but little narrower than the pars thoracica, the clypeal region convex. Stria thoracica short but distinct. Anterior row of eyes procurved, much shorter than the posterior row. Posterior row of eyes straight or nearly so, the medians much

nearer to each other than to the laterals; the laterals taken with anterior medians forming a strongly recurved row. Area of median eyes longer than wide, narrower in front than behind Lateral eyes widely separated from each other. Claw of chelicera small, normal; furrow short, its margins unarmed; lateral condyle strongly developed. Sternum pointed behind. Coxae of the fourth legs contiguous. Median claw of tarsi borne on an empodium. Tarsal claws with numerous, uniseriate teeth. Posterior legs strongly spined, the usual verticillate group at end of metatarsus. The usual dense patch of seriate setae at distal end of metatarsi. Spinnerets short, anterior and posterior pairs subequal, contiguous.

GENOTYPE.— *Naibena barrona*, sp. nov.

NAIBENA BARRONA, sp. nov.

Carapace brown, dusky on the sides. Sternum and legs yellow. Abdomen black above, with three pairs of white spots and a single median white spot at caudal end. Venter pale, with a median longitudinal dark line and, on each side, a dark band arising from caudal end of median line at base of spinnerets and running obliquely cephalodorsad to merge in dark of sides. Anterior row of eyes decidedly procurved; medians much smaller than the laterals, their diameters comparing about as 3:5; medians about their diameter apart, farther from the laterals. Eyes of posterior row equal to each other and to anterior laterals; medians separated by rather less than a third their diameter, nearly twice (1.8) their diameter from the laterals.

Length, 5 mm.

TYPE.— M. C. Z. 1,267.

LOCALITY.— Barro Colorado Island. W. C. Allee. One not fully adult female.

THERIDIIDAE.

VIBRADELLUS, gen. nov.

Pars cephalica strongly slanting forward from the stria thoracica. The four median eyes on a forwardly directed process of pedicel as in Vibrada and each lateral eye on a small individual pedicel widely removed from the median eyes. Abdomen large, subcircular in outline as viewed from above, dorsally flattened, not elevated as in Ulesanis, the tegument hard and granular but not with distinct scuta such as are present in Vibrada. Sternum cordate.

GENOTYPE.— *Vibradellus carolinus*, sp. nov.

VIBRADELLUS CAROLINUS, sp. nov.

♂. Carapace dusky brown, without definite markings. Legs yellow except the femora which are brown or dusky or yellow only at proximal end. Abdo-

men at present yellow, but it may be more or less bleached. The carapace widest posteriorly, narrowing forwards to posterior lateral eyes and then more abruptly narrowed to the pedicel carrying median eyes; on each side posteriorly a patch of conspicuous pointed tubercles or teeth. Anterior median eyes carried far forward above the laterals. Posterior row of eyes strongly recurved, the lateral eyes widely removed from the medians. Legs unspined ventrally, but all patellae with several short spines or teeth dorsally and the tibiae with at least one at distal end above. Abdomen flattened or somewhat concave above, semicircular in outline behind, with a rounded shoulder or protuberance a little behind each anterolateral corner. Tibia of palpus with a distally truncate, laminate process on ventral side; tarsus proportionately large.

Length, about 3 mm.

TYPE.— M. C. Z. 1,268.

LOCALITY.— South Carolina. One male from stomach of toad.

DIPOENOIDES, gen. nov.

Cephalothorax very high, the height exceeding the width and length, and the width exceeding the length. Clypeus several times higher than length of chelicerae which are weak. Posterior row of eyes procurved, its eyes nearly equidistant. Anterior median eyes widely separated, much closer to the laterals than which they are smaller.

GENOTYPE.— *D. apachecus*, sp. nov.

Differs from Dipoena in having anterior median eyes smaller than the laterals and the posterior row procurved instead of recurved.

DIPOENOIDES APACHECUS, sp. nov.

♂. Carapace dusky yellow. Sternum nearly black. Legs yellow, spotted with black. Abdomen largely bleached out in type but apparently with a folium in outline on dorsum, the sides outside of and below the wavy line of folium darker than mid-dorsal region, spotted. The setae on dorsum of abdomen stout, spinescent. Tarsus of palpus proportionately very large; bulb with two processes arising distad of middle and extending distad beyond the end of the cymbium; of these processes the inner (mesal) one, probably the embolus proper, is more slender and is nearly straight; the outer process is stout proximally but is acutely narrowed distally and is somewhat twisted in proximal portion.

Length, about 3 mm.

TYPE.— M. C. Z. 1,269.

LOCALITY.—Arizona: Yavapai Co. One male from stomach of toad.

Linyphiidae.

Bathyphantes castor, sp. nov.

♂. Carapace and sternum dusky yellow. The legs also dark yellow proximally, lighter distally. Abdomen black, without markings. Posterior row of eyes slightly procurved; medians subequal to the laterals, somewhat more than their radius from each other and about their diameter from the laterals. Anterior median eyes smaller than the laterals, their diameters being about as 4:5, about their radius from each other and their diameter from the laterals. Clypeus depressed just below eyes and then slanting forward to base of chelicerae. Upper margin of furrow of chelicera with four teeth of which the two most distal ones are raised on a common base. Lower margin with two teeth which are minute and close together and opposite the two connate ones of upper margin. Embolus of palpus curved around distal end of bulb in the typical manner; paracymbium slender, distally geniculate and almost uncate.

Length, 2.5 mm.
Type.— M. C. Z. 1,270.
Locality.— Alaska: Beaver Mountains, May, 1920. Two males.

Argiopidae.

Glenognatha centralis, sp. nov.

♂. As the type was taken from the stomach of a toad, details of coloration are largely lost. At present the carapace, sternum, and chelicerae are brown, the legs yellow, and the abdomen dark, blackish, but it may have had lighter markings. On the lower side of furrow of chelicera there are three teeth, a small one near base of claw, two much larger onés farther caudad in line oblique to the axis of the claw, when closed. On the upper margin of the furrow of the chelicera there are also three long, erect teeth of which the middle one is longest and the proximal one smallest. The chelicerae are strongly divergent and their distal ends are separated by a distance greater than their length. Distal process on bulb of palpus in the form of a chitinous blade rolled at the end.

Length, about 2.2 mm.
Type.— M. C. Z. 1,272.
Locality.— Panama. One male from stomach of Bufo sp.

Eustala conformans, sp. nov.

♀. Carapace and sternum dull yellow, without markings. Legs dull yellow, in part dusky above, clear yellow below. Abdomen broadly sub-

triangular, rounded at corners, flattened above. Dorsum of abdomen grayish yellow anteriorly, becoming gray in middle and posterior regions. A median cuneate mark at base with narrow end forward; behind middle a dark band which abruptly narrows and continues to spinnerets as a band with dentate margins and of uniform width. Venter yellowish, dusky in front of spinnerets and in a cross-band at middle. Sides dark gray, streaked with black below. The epigynum has much the general form of that of *E. semifoliata* Cambridge, the scape long, strongly cross-wrinkled, narrowed distad to the base of the smooth apical process which is shorter and thicker than in *semifoliata*.

Length, 4.2 mm.
TYPE.— M. C. Z. 1,273.
LOCALITY.— Barro Colorado Island. W. C. Allee. One female.

EUSTALA TUCEPS, sp. nov.

♀. Carapace with pars thoracica yellow, the pars cephalica abruptly darker, brown or light chestnut, the chelicerae a little darker. Sternum and legs yellow, the anterior pairs darker, somewhat dusky yellow. Dorsum of abdomen yellowish, with a folium outlined in black, the sides of folium wavy; a median longitudinal black line broken anteriorly and the posterior portion less distinct. Sides of abdomen dark, the venter gray, without markings. The epigynum is characteristic, the posterior plate broad and wholly smooth, notched at the middle behind, and the forwardly directed scape very short; openings of spermatheca widely separated. Abdomen subelliptic in outline as seen from above.

Length, 7 mm.
TYPE.— M. C. Z. 1,274.
LOCALITY.— Barro Colorado Island. W. C. Allee. One female.

PSEUDOMETA BIOLOGICA, sp. nov.

♀. Carapace yellowish white with the pars cephalica above dusky or black, the dark color extending back over the thoracic stria. Sternum black, with a median longitudinal yellow stripe acutely pointed behind. Legs yellow; the anterior femora dusky distad of the middle and the posterior femora with two dusky annuli distad of middle, the joints elsewhere with numerous, mostly fine, dark dots on each of which a seta is inserted; tibiae similarly finely dotted with dark, a more definite dark annulus at distal end on anterior legs and two annuli on posterior tibiae; metatarsi also finely dotted, with a tendency to form three or four annuli on anterior legs, the distal two of these annuli being most distinct, and three on posterior legs. Abdomen dirty white above; a dorsal folium outlined in black, a longitudinal line and veins running out from

it faint, but the wavy border distinct, the folium discontinuous caudally however; numerous black spots and streaks on each side; venter with an unevenly edged, longitudinal black band from spinnerets forward across epigynum. Epigynum strongly chitinized, wide in proportion to length; the usual hammer-headed or anchor-shaped median piece shaped much as in *P. alboguttata* Cambridge, but the septal piece not produced at anterior end as in that species, the median piece depressed at a marked angle to the anterior part of plate. Abdomen elliptic in outline.

Length, 10 mm. Length of cephalothorax, 3.5 mm.

Type.— M. C. Z. 1,275.

Locality.— California: Pacific Grove, at the Hopkins Laboratory. R. V. Ellis. Three females.

Thomisidae.

Xysticus lassanus, sp. nov.

♂. Color-pattern of the ordinary type. Carapace blackish along sides, with a wide median longitudinal light stripe as wide anteriorly as eye-area, the stripe embracing numerous dark dots and two rather weakly defined dark marks placed longitudinally back of posterior median eyes. Sternum light, with numerous small brown spots. The species is characterized by the palpus. In this the tibial apophysis presents two branches of which the dorsal one is pointed while the ventral one is broader, laminate, with its distal end oblique. Embolus evenly curved around the periphery of the bulb. A pointed apophysis below embolus on mesal side and a low median apophysis with principal point directed mesad.

Length, about 4.8 mm. Length of cephalothorax, 2.2 mm.

Type.— M. C. Z. 1,277.

Locality.— Texas: Roberts. One male in poor condition from *Geococcyx californicus* (Lesson).

Selenopidae.

Selenops salvadoranus, sp. nov.

♀. Carapace brown, darker at margins. Sternum and coxae of legs beneath yellow, the sternum somewhat dusky except in the middle area. Legs yellowish; femora with two large dark spots beneath; tibiae and metatarsi each with two dark annuli which are less pronounced dorsally. Abdomen dark gray above, paler beneath. Posterior lateral eyes somewhat less than half the diameter of the anterior laterals (13:30). Anterior median eyes three fourths their diameter apart. In the epigynum of the female the median piece is

somewhat diamond-shaped with one point extending toward caudal median notch and the opposite one continuing forward as a median raised line.

Length, 13 mm.
TYPE.— M. C. Z. 1,278.
LOCALITY.— San Salvador, January, 1920. One female.

SPARASSIDAE.

OLIOS YUCATANUS, sp. nov.

♀. General color of carapace yellow, a faint dark line back of each posterior median eye and on each side of pars cephalica some distance back of the lateral eye, two dark lines somewhat oblique to each other. Sternum and coxae of legs clear light yellow. Legs yellow, without markings. Abdomen above yellowish marked with numerous small dark dots which, however, leave a clear spear-mark at base behind which the dots on the median line are somewhat heavier than elsewhere. Venter yellow, a broad dusky area back of genital furrow and a dusky spot each side of epigynum. Anterior median eyes a little larger than the anterior laterals and also larger than the posterior medians, less than their diameter apart, and slightly nearer to the laterals. Posterior eyes equal, the medians a little nearer to each other than to the laterals. The epigynal depression, viewed from behind, wider than long, not narrowed at the open or caudal end, its bordering rim chitinous, the border thickening in front crossed by a median longitudinal furrow; the median chitinous piece filling the depression, wider than long, convex behind.

Length, 10.5 mm.
TYPE.— M. C. Z. 1,279.
LOCALITY.— Yucatan: Chichen Itza, 1 March, 1904. L. J. Cole. One female.

CTENIDAE.

CTENUS DOLOMEDES, sp. nov.

♂. Under alcohol the carapace shows a darker median band as wide as the eye-area, and the lateral borders are also darkened, the sides otherwise yellow. Sternum and coxae of legs yellow. Legs with femora yellow below, crossed above with dusky bands or spots which are not sharply limited; tibiae darkened proximally and distally; metatarsi with dusky annulus at each end and one at middle. The abdomen with a sagittate mark at base above followed by several dark chevrons on posterior portion; dark spots on sides of dorsum. In a partly grown specimen there is a broad dark band over the entire length of abdomen, the band solid except for two spots enclosed anteriorly. Venter pale at sides, with a conspicuous median longitudinal dark band which ends a little

in front of spinnerets and has irregular edges. Area of median eyes wider than long (nearly as 6:5), much narrower in front than behind (nearly as 4:5). The anterior median eyes much smaller than the posterior medians. Second row of eyes decidedly procurved. Posterior medians and posterior laterals equal in size or nearly so. In the palpus the tibial apophysis is moderately broad, with distal end slightly convex and not at all acuminate, the apophysis wholly free from teeth or spines. The legs are unusually long and tibia plus patella III are decidedly longer than the cephalothorax.

Length, 10.5 mm. Tibia + patella IV, 9.25 mm.

Type.— M. C. Z. 1,280.

Locality.— Barro Colorado Island. W. C. Allee. One adult male and an immature female.

Characterized among other Central American species of the genus by coloration, the very long legs, and the structure of the palpus, which is distinctive.

Clubionidae.

Clubiona bufonis, sp. nov.

♂. Carapace and sternum light brown. Legs yellow. Abdomen gray. Posterior row of eyes straight or nearly so, much longer than the anterior row, the eyes widely separated with the medians considerably farther from each other than from the laterals. The species is readily differentiated by the form of the tibial apophysis. This presents two main branches; of these the upper and mesal one is a lamina widened distad and presenting a long distal edge like an ax; the lower branch is divided into two subequal processes which are blade-like, but rather narrow and distally truncate. Bulb strongly chitinous; a large median chitinous plate has an acute spur from base on outer side, the principal part of this plate extending forward over bulb as a very broad, slightly twisted lamina. The embolus, broad and blade-like at base and becoming distally slender, curves from mesal side around distal end of bulb and back proximad on ectal side.

Length, about 3.5 mm.

Type.— M. C. Z. 1,282.

Locality.— Upper Missouri River. One male from stomach of toad.

Chiracanthium falculum, sp. nov.

♂. Carapace and sternum yellowish brown, the legs similar but more yellow beneath. Abdomen gray, unmarked. Anterior row of eyes distinctly recurved; median eyes less than their radius apart, a little farther from the laterals; the medians a little larger than the laterals. Posterior row of eyes

straight or very slightly procurved, considerably longer than the anterior row, the medians farther from the laterals than from each other as usual. Tibiae I and II with three pairs of spines below and with three spines on anterior face and two on posterior face. The tibial apophysis as viewed from below is nearly straight and of uniform thickness until the distal fourth or fifth of length is reached when it abruptly narrows into a small, curved, sickle-like blade. Embolus encircling the bulb.

Length, 9 mm. Tibia + patella I, 6 mm.; tibia + patella IV, 5.2 mm.

TYPE.— M. C. Z. 1,283.

LOCALITY.— Florida: Sebastian, 14 February, 1919. A. Weese. One male.

ANYPHAENA INFERENS, sp. nov.

♀. Carapace brown on the upper part of sides, paler below and in a mid-dorsal band. Sternum yellow. Legs light brown, paler beneath. Abdomen marked above with a dark median longitudinal dentate band which tends to break into distinct chevrons on caudal portion; at sides many small dark spots and streaks. Venter paler yellow, unmarked. Anterior tibiae with four pairs of long ventral spines, three spines on anterior face and two on posterior. Anterior metatarsi with two pairs of ventral spines. The epigynum presents a median longitudinal tongue extending from anterior end and ending about one fourth the length from the caudal margin; in front of caudal margin two transversely elliptic dark areas narrowly separated from each other at middle; on median tongue at its anterior end a second short process projecting caudad.

Length, up to 7 mm.

TYPE.— M. C. Z. 1,354.

LOCALITY.— Costa Rica. Seven females.

MAZAX SEGREGATA, sp. nov.

♀. Posterior row of eyes straight or but little procurved; the eyes equal or very nearly so; median eyes separated by a little more than their radius and somewhat closer to the laterals. Anterior median eyes smaller than the laterals (ratio of diameters as 7:9); medians less than their radius apart, closer to the laterals; the row strongly procurved, a line through the centers of the medians being nearly tangent to caudal edges of laterals. Clypeus a little lower than diameter of an anterior lateral eye. Tibia I with six pairs of spines beneath; tibia II with five pairs of spines beneath. Metatarsi I and II with two pairs of spines ventrally. Lower margin of furrow of chelicerae with two teeth. Basal dorsal scutum of abdomen smooth and shining, wholly without teeth or processes. Carapace and sternum nearly black. Chelicerae blackish

down front face. Femora of legs mostly black, yellowish on ventral side and distally, especially on anterior pairs; other joints of anterior pairs yellow or tibiae but little darkened. Third legs with tibiae and metatarsi darkened along the sides. In fourth legs the tibiae and metatarsi are almost wholly black, the tibiae lighter at ends.

Length, 6.5 mm.
Type.— M. C. Z. 1,285.
Locality.— Barro Colorado Island. W. C. Allee. One female.

Distinguished from other known species in having the anterior median eyes smaller than the laterals, and with six pairs of spines under tibia I, etc.

Trachelas barroana, sp. nov.

♂. Carapace and mandibles dark chestnut. Sternum and coxae of legs beneath and the femora of first legs a lighter chestnut; other joints of first legs and other legs, except possibly the second, which are missing from the type, yellowish. Abdomen gray, with a large elliptic dorsal area of weakly orange cast; venter a paler gray and unmarked behind genital furrow in front of which it is a dilute yellowish chestnut. Carapace strongly narrowing behind. Carapace and mandibles densely rugulose-punctate. Posterior row of eyes strongly recurved; medians about once and a fourth their diameter from each other and nearly twice their diameter from the laterals. Area of median eyes wider behind than in front nearly in ratio 16:13. Anterior row of eyes rather strongly procurved; the median eyes slightly larger than the laterals, about one fourth their diameter apart and twice as far from the laterals. Chelicera with four teeth on lower margin of furrow. First legs with numerous black teeth or cusps along ventral surface of tibia, metatarsus, and tarsus. Fourth legs without cusps, but the third leg with cusps on anterior side of patella, tibia, and metatarsus. Tibia of palpus twice as long as greatest thickness.

Length, 6 mm.
Type.— M. C. Z. 1,286.
Locality.— Barro Colorado Island. W. C. Allee. One male.

Corinna eutypa, sp. nov.

♀. Carapace and chelicerae chestnut colored. Sternum yellow at middle, dusky elsewhere. Palpi and anterior legs dilute chestnut, lighter proximally, the posterior pair somewhat lighter except that metatarsi and tarsi are equally dark. Abdomen greenish gray, with a dark area adjacent to the pedicel and two dark bands across dorsum and down sides farther caudad, these bands interrupted on the middorsal line. Venter unmarked. Anterior row of eyes decidedly procurved, the eyes equal and nearly equidistant. Posterior row of

eyes longer than the anterior, procurved, the eyes equal and equidistant. Lower margin of furrow of chelicera with four stout teeth. Tarsus I with four pairs of spines beneath and in addition a pair of small, almost setiform ones at distal end. Structurally approaching *C. bulbosa* Cambridge, the epigynum being also of the same general type.

Length, 9 mm.
TYPE.— M. C. Z. 1,287.
LOCALITY.— Barro Colorado Island. W. C. Allee. One female.

CHEMMIS BARROANUS, sp. nov.

♂ (im.). Carapace light yellow; a black marginal stripe on each side; a brown longitudinal stripe with irregular edges and partly interrupted on each side in line with the lateral eyes, the two brown stripes uniting across posterior declivity; also a brown median mark in front of stria and in front of this a brown line; a small brown spot back of each posterior median eye. Chelicerae yellow, with a brown area down anterior face. Sternum and coxae of legs pale, unmarked. Legs yellow, annulate with dark, the annuli on femora interrupted above and below, the dark areas on metatarsi embracing all or nearly all of the article. Abdomen yellowish white above with numerous small brown spots; venter pale, without markings. Posterior row of eyes slightly recurved, the eyes nearly equidistant. Distinguished from the Costa Rican *C. frederici* Simon, the genotype, in having six pairs of ventral spines on tibiae I and II instead of five pairs.

Length of the not quite mature male, 7 mm.
TYPE.— M. C. Z. 1,288.
LOCALITY.— Barro Colorado Island. W. C. Allee. One not quite adult male.

AGELENIDAE.

ISHANIA, gen. nov.

Cephalothorax broad anteriorly where much wider than the eye-area; highest behind eyes, the eye-region slanting forward. Clypeus vertical, several times higher than length of median eye-area. Anterior row of eyes strongly procurved, the median eyes smaller than the laterals. Posterior row of eyes procurved, the eyes subequal, or the medians a little smaller. Area of median eyes wider behind than in front, longer than wide. Lower margin of chelicera wholly unarmed, the upper margin also without teeth but with a series of long curved setae. Labium triangular, nearly as long as endites. Endites narrowed distally. Lower spinnerets stout and cylindrical, contiguous.

Upper spinnerets more slender, plainly two-jointed, but the second joint decidedly shorter than the first. Tibia of male palpus with an elongate apophysis.

GENOTYPE.— *Ishania tentativa*, sp. nov.

Suggests Thaida Karsch, also based upon a Costa Rican species, in the eye characters and the very high clypeus, but it lacks the strongly bisinuous clypeal margin of that species and has the labium triangular instead of quadrate. Also in the male palpus the tibia is much longer in Thaida and no apophysis is shown for it in Karsch's figure.

ISHANIA TENTATIVA, sp. nov.

♂. Carapace brown, legs yellow, and abdomen gray without markings that show in the type. Cephalothorax highest near caudal end of pars cephalica from where it slopes evenly and convexly to caudal margin and less strongly forward to first eye-row. Clypeus very high, vertical, its lower margin nearly evenly convex but somewhat flattened at middle. Leg I missing. Tibia II with two spines in series under anterior border, a third, basal, spine in line with the other two apparently lost. Metatarsus II with one ventral spine proximad of middle and a smaller submedian spine on anterior face. In the palpus the tibia proper is no longer than the patella but it is produced into a nearly straight apophysis longer than the joint proper and extending distad at side of bulb at edge of cymbium. The embolus arising on mesal side curves across bulb and back as far as base of patella where it is broken off, apparently having had an even greater length.

Length, about 3 mm.

TYPE.— M. C. Z. 1,289.

LOCALITY.— Costa Rica. One male from stomach of toad.

PISAURIDAE.

ENNA NESIOTES, sp. nov.

♀. Carapace dusky brown, with a narrow median pale stripe which is pointed down the posterior declivity and is triramous in front, a lateral branch ending behind each posterior lateral eye and sometimes disconnected at base, and a narrow median branch or line running forward; also on each side a narrow supramarginal light band which is interrupted or broken into a series of spots. Chelicerae chestnut-black. Sternum yellowish, dusky about borders. Legs dusky, sometimes of a greenish cast, ringed or spotted with yellow, the annulation most distinct on femora, the tibiae ordinarily showing three annuli. Abdomen dark over the sides and dorsum, above with a pale, caudally pointed, median mark at base and each side of this and continuing farther back an irregular series of small light dots which may be obscure. Venter grayish,

without markings, the epigynum light chestnut. The epigynal area shows a black, more chitinous, rim behind and laterally which is not incised at middle behind as it is in *E. velox;* there is a prominent convex fold on each side of median longitudinal depression or furrow, but between the folds there is no median lobe such as Cambridge represents for *E. velox.*

Length, 7 mm.

Type.— M. C. Z. 1,290.

Locality.— Barro Colorado Island. W. C. Allee. Three adult and one immature females.

Lycosidae.

Pirata pagicola, sp. nov.

♀. Under alcohol the carapace shows a background of yellow with the usual V-shaped mark behind the eyes, a broad dark band along each side and a narrow dark stripe close to each margin; eyes edged with black and a black transverse area back of eyes of second row. Sternum clear yellow. Legs yellowish, the femora under the lens appearing obscurely ringed with dark, the tibiae with more vague indications of annuli. The abdomen dark above, with a paler basal mark and, over entire length, a series of paired white spots of which those in the posterior region are more or less connected by straight transverse lines; no true chevron marks such as are so pronounced in *P. felix* Cambridge, a form reported from Guatemala and Mexico. Venter yellow, unmarked. Epigynum of the typical general form, the two lobes rather close together, the opening on each distinct and lying obliquely; between the bases of the lobes, at bottom of excavation between them, two chitinous projections which are the continuations of parallel ridges running cephalad.

Length, 3.5 mm.

Type.— M. C. Z. 1,292.

Locality.— Barro Colorado Island. W. C. Allee. One female.

Allocosa panamena, sp. nov.

The types of this species were taken from the stomach of a toad and as a result do not show coloration well. However, it is obvious that the legs are annulate and the carapace shows a lighter dorsal area and a lighter supramarginal stripe, a color-pattern being apparently more strongly marked than is usual in this genus. The form seems clearly distinct in the palpus of the male. In this the distal branch of the scopus is long, extending transversely to the edge of the cymbium where it bends caudad abruptly; the inferior branch of scopus shorter, acute, not curved; from the guide the usual chitinous process extends transversely to edge of alveolus and is acutely pointed and

straight; from the opposite side of conductor the embolus arises and curves proximad and then transversely behind the scopal fold. The spines of anterior tibiae long.

Length of male, about 3 mm.; of female, 4 mm.

Type.— M. C. Z. 1,293.

Locality.— Panama. One male (holotype) and one female (allotype) from stomach of Bufo.

Allocosa pylora, sp. nov.

♂. Carapace brown, without markings except that the eye-region is blackish, clothed with very sparse black hairs. Sternum black, the coxae of legs brown. Legs brown; femora with two black annuli broken below and also more or less above; tibiae black at ends; metatarsi with three black annuli. Abdomen brown above, with black dots more or less connected and outlining a basal mark and several chevrons behind; sides darker; venter light, without spots but with two faint parallel darker lines along middle. Tibia I with five spines beneath an unpaired one at base and a pair each at middle and at distal end, otherwise unarmed. The bulb of the palpus is characteristic in having the long principal branch of the scopus bent near its middle abruptly ventrad and thus away from the bulb; the process from the conductor is simple, not divided as in *rugosa* nor folded as in *parva*.

Length, 7.2 mm.

Type.— M. C. Z. 1,295.

Locality.— Texas: El Paso. One male.

Allocosa virgo, sp. nov.

♀. Carapace light chestnut brown without lighter stripes or markings. Sternum yellow, coxae of legs brown. Legs brown, in the type, long preserved in alcohol, no annuli obvious but indications are present that the posterior tibiae at least may have been definitely annulate in life. Abdomen pale along middle of dorsum, darker at the sides, the pale band enclosing a spear-mark in outline at base. Venter clear yellowish brown. Lower margin of furrow of chelicera with three teeth. Tibia I with three pairs of spines beneath, the spines of basal pair overlapping the bases of those of the second, the distal pair reduced. The species is well characterized by the form of the epigynum. This is of the general type of that in *A. evagata* Chamberlin, but the spermathecal openings are much nearer together; in front of each opening a dark circular area.

Length, 8 mm.

Type.— M. C. Z. 1,296.

Locality.— Virginia: Fairfax. Two males.

Lycosa benedicta, sp. nov.

♀. A form in general structure allied to *L. coloradensis* and *L. evagra*. It differs superficially from these species in having the venter of the abdomen behind the genital furrow solid black while light colored in front of the furrow and about bases of spinnerets. Abdomen above with a solid dark basal mark followed behind by several black triangular marks; the dorsum each side of basal mark clothed with gray and brown hair intermixed or in separate spots and streaks. Sides of abdomen above dark. Sternum solid black, the coxae of legs beneath brown or dusky, perhaps black in specimens in full color. Carapace chocolate-brown, the tegument showing a light spot about and in front of stria, the spot with radiating branches; a light supramarginal stripe on each side. Legs brown, the femora with two cross-bars of black above; patellae black beneath and all tibiae black at distal end beneath. The epigynum more strongly constricted in front of caudal cross-piece than in *coloradensis*, but nearly the same as in *evagra*.

♂. Coloration as in the female.

Length of female, 15 mm.; of cephalothorax, 9 mm. Length of male, 15 mm.; of cephalothorax, 8.5 mm.

Type.— M. C. Z. 1,298.

Localities.— Virginia: Alexandria. One male and one female. Alabama: Selma, a male and a female. Texas: Dallas, a female. Illinois: Chicago, a male. Arizona, one male and one female.

Lycosa evagra, sp. nov.

♀. Integument of carapace reddish brown, without distinct lighter stripes, clothed with gray hair. Sternum and coxae of legs beneath solid black. Legs brown, the tibiae black at distal end, the legs otherwise unmarked. Abdomen with a dark basal mark which is furcate at its end at middle of abdomen and is dentate on sides; the basal mark followed behind chevron marks; on each side of dorsum a row of larger marks and many much smaller dots. Venter solid black in front of genital furrow; numerous small brown dots behind the furrow and solid brown or somewhat blackish at base of spinnerets, the spinnerets themselves black or nearly so. The epigynum has the guide widely expanded at middle where it occupies nearly the full width of the cavity, but immediately behind this it is abruptly narrowed to a slender pedicel connecting with the cross-piece as in the preceding species; the cross-piece moderately long, rather strongly curved forwards at ends.

Length, 22 mm. Length of cephalothorax, 9.5 mm.

Type.— M. C. Z. 1,303.

Locality.— Mexico: Chihuahua, Montezuma Station. One female.

Lycosa apacha, sp. nov.

♀. This form belongs with those having a wide median longitudinal light band on carapace, this band widest on head at the caudal part of which it is rather abruptly narrowed, the band densely clothed with white hair. Sternum and legs brown, the posterior tibiae, at least dark at ends. (Anterior legs missing). Abdomen with basal dark mark followed by chevrons. The species will be readily recognized by its very characteristic epigynum. This is short, considerably wider than long; cross-piece of guide decidedly longer than the septal piece and extending almost entirely across caudal end of epigynal area; septum narrow at junction with cross-piece, strongly widening cephalad, almost fan-shaped.

Length, 14 mm. Length of cephalothorax, 7.5 mm.; of tibia + patella IV, 8 mm.

Type.— M. C. Z. 1,304.

Locality.— Arizona. One female in poor condition.

Lycosa parthenus, sp. nov.

♀. A species in the *avara* group. From *avara* it differs, as does *gosiuta*, in lacking a median process on the cross-piece of guide in epigynum and in having the ends of the cross-piece bent far forwards, also as in *gosiuta*. The ends of the cross-piece in the present species, however, extend more obliquely and reach relatively farther forward, extending, in fact, farther forward than the septum. It is a smaller form than either of the other species mentioned.

Length, 8 mm.

Type.— M. C. Z. 1,305.

Locality.— Florida: Bartow. One female.

Lycosa tusapa, sp. nov.

♂. Carapace dark chocolate-brown on sides; a wide median pale stripe narrowing forward between eyes of third row, clothed with white hair which continues in a line forward between eyes of second row; on each side a supramarginal light band also clothed white hair. Sternum and coxae of legs black. Legs brown, not annulate but first pair with femur, patella, and tibia black or nearly so; femur of second legs also blackish; femora of posterior legs less darkened. Abdomen above with a solid spear-mark which is acutely pointed behind, where it divides two chevron marks and ends on a third one behind which there are two or three other chevron marks, the most caudal of these being interrupted at the middle line. Sides of abdomen dark, blackish above, lighter below. Venter solid black behind genital furrow and in a median band

in front of it, the black area bordered by yellow on each side. Lower margin of furrow of chelicera with three teeth. The palpus very characteristic. The scopus is transversely elongate, extending past middle line toward mesal side of bulb where it ends in two teeth or processes, the continuation of transverse folds or ridges. Embolus very short and bent at right angles at middle.

Length, 9 mm.
TYPE.— M. C. Z. 1,306.
LOCALITY.— California: Goose Lake.

LYCOSA EUTYPA, sp. nov.

♂. Carapace with a narrow median pale line which extends forward between eyes of last two rows and down the front; also a narrow but very distinct supramarginal line on each side. Sternum and coxae of legs below yellow or yellowish brown. (In a paratype from Barro Colorado Island the sternum has a black stripe on anterior half each side of middle). Legs yellowish brown, not annulate. Abdomen above with a median longitudinal dentate band which reaches to the spinnerets and a dark band on each side running back from each anterior corner and uniting with the median band above spinnerets. Venter darker at sides, pale in middle, the lighter area enclosing a somewhat darker median band for a distance back of genital furrow. Palpus slender, the tarsus not heavy. Scopus of palpus submedian in position and rather weakly developed.

Length, 11 mm.; cephalothorax, 6 mm.; tibia + patella I, 6.2 mm.; tibia + patella IV, 6.4.
TYPE.— M. C. Z. 1,307.
LOCALITY.— Panama, Thomas Barbour. One male. Barro Colorado Island. James Zetek. One adult and one immature male.

LYCOSA ARCHAEOLOGICA, sp. nov.

♂. Carapace brown, with a median light stripe narrower than the eye-area anteriorly where it passes between posterior eyes and ends abruptly before reaching eyes of second row. Sternum black and the coxae of legs beneath dusky and probably also black when in full color. Legs brown, darker distally and paler beneath, not annulate, or posterior tibiae and metatarsi vaguely so, the fourth tibiae being dark at distal end. Abdomen above with a median series of wedge-shaped marks with apices forward, of which the basal one is much largest and all of which may be connected with each other; a black spot on each anterior corner followed behind by a series of angular marks or these also united into a more or less continuous band. Entire venter, both in front of and behind genital furrow, black. In the palpus the scopus in the more

usual lateral position; embolus more strongly curved than in the preceding species.

Length, 13 mm.; cephalothorax, 7.8 mm.; tibia + patella I, 10 mm.; tibia + patella IV, 10 mm.

TYPE.— M. C. Z. 1,310.

LOCALITY.— Yucatan: Chichen Itza. One adult male and one male not quite adult.

LYCOSA MAYA, sp. nov.

♀. Carapace seen under alcohol showing a median longitudinal light stripe narrowing to a point down the posterior declivity and anteriorly widening and enclosing the eye-area beyond which it extends on both sides, its edges uneven; sides brown. Sternum and coxae of legs dusky brown. Legs light brown, darker distally, without distinct annuli excepting the posterior tibiae which have a dark ring at each end, and the posterior metatarsi. Abdomen brown above, with a black spot on each anterior corner, a dark basal spear-mark in outline, this blunt behind and the line more or less broken; small black dots over entire surface; venter solid black behind genital furrow, the spinnerets yellow. Guide of epigynum anchor-shaped, the median piece moderately dilated anteriorly and the cross-piece long, as long as the median septum measured to caudal edge, bowed up at ends.

♂. Color as in the female. In the palpus the scopus is small and lies more near the center of the bulb than usual; embolus slender and evenly curving behind (above) and distad of scopus.

Length of female, 12 mm.; cephalothorax, 7 mm.; tibia + patella IV, 7.2 mm.

TYPE.— M. C. Z. 1,311.

LOCALITY.— Yucatan: Chichen Itza. One female (holotype) and one male (allotype).

LYCOSA GOSOGA, sp. nov.

Lycosa nidifex Chamberlin (not of Marx), Can. ent., Jan., 1910, **42**, p. 17, fig 3, 4.

♀. Belonging to the Geolycosa group. It is like *fatifera* in having no light bands on the carapace, the tegument of which is chestnut in color and is clothed with grayish hair, or mostly such. Sternum and coxae of legs yellow. Legs brown, the femora lighter beneath excepting that the patella, tibia, tarsus, and metatarsus of legs I and II are black beneath. The abdomen is gray above, with a vague basal spear-mark. Venter unmarked. The epigynum is in general similar to that of *L. arenicola* but presents a distinct convexity at middle of posterior margin of guide instead of having this margin evenly rounded and less convex; the anterior end of septal piece is slightly bent.

TYPE.— M. C. Z. 1,313.

LOCALITY.— California, Los Angeles. One female. The specimens furnishing the basis of the description (Can. ent., **42**, p. 17) were noted as probably from Arizona or southern California and are in the American Museum of Natural History.

SCHIZOCOSA DUPLEX, sp. nov.

♂. Carapace dark brown on the sides, a wide median dorsal yellowish stripe extending forward between eyes of third row and a light supramarginal stripe on each side. Sternum and coxae of legs yellow. Legs brown, without annuli, the femora, patellae, and tibiae of first pair darkened, but with no brush of dark hair. Abdomen yellowish in a broad band down the middle, black at sides; the light area enclosing a basal mark in outline followed by several chevron-shaped dark lines. Venter light except for a few dark dots. The palpal organ is of the *ocreata* type but the anterior horn is very short, scarcely surpassing the anterior edge of the alveolus, and it presents various differences in other details.

Length, 6 mm.

TYPE.— M. C. Z. 1,314.

LOCALITY.— Virginia: Fairfax. Three males.

Easily distinguished from males of *ocreata* and *bilineata* in lacking the characteristic brush on anterior tibiae and from *saltatrix* in the form of the palpal organ.

SCHIZOCOSA PUEBLA, sp. nov.

♂. The general coloration as in the preceding species. No brush on anterior tibiae. It is clearly distinct from *duplex* and the other known species in the details of the palpal organ. In this the anterior lobe lacks the horn-like development present in *ocreata* and less developed in *duplex*, presenting instead a fold similar to that of *saltatrix* but with the rugose area of the lobe much more extensive; the scopus is conspicuously different from that in *saltatrix*, being in the form of a transverse ridge with a stout spur at mesal end and a process at ectal end that extends dorsodistad over the ectal fold.

Length, 8 mm.

TYPE.— M. C. Z. 1,316

LOCALITY.— New Mexico: Albuquerque. One male.

PARDOSA YAVAPA, sp. nov.

♀. With the more usual markings on carapace and dorsum of abdomen. Sternum black. Venter of abdomen immaculate. Legs annulate. The

species is characterized by the form of the epigynum. This is comparatively short and broad, the general form and proportions being much as in *utahensis* Chamberlin. The general epigynal area is hexagonal with width between the two lateral angles, which are somewhat extended into shoulders, greater than the length; behind anterior margin is a short, transverse chitinous rim and behind this are two oblique chitinous folds meeting in an angle on middle line; just within this angle is the short septum of the guide, this expanding abruptly behind into a spade-like terminal plate shaped something like the corresponding part in *Lycosa gulosa*.

Length, 5.2 mm.

Type.— M. C. Z. 1,317.

Locality.— Arizona: Yavapai Co. One female from stomach of toad.

Salticidae.

Myrmarachne tayabasanus, sp. nov.

In general structure and appearance suggesting *M. bellicosus* (Peckham), known from Luzon Island, but distinguishable in numerous features. The chelicerae are shorter and are more evenly, less clavately enlarged distad. The mesal surface of chelicera flattened and meeting the dorsal surface at right angles; dorsal surface roughened, more granulose and less rugose than in *bellicosus*. The posterior surface of the pars cephalica is more nearly vertical than in the other species and the constriction behind it deeper. While the general color in *bellicosus* is deep brown, it is black in the present form. White hairs form a band across clypeus and extend about the eyes. Abdomen black above; venter pale, the light color rising higher on the sides in an angle near the middle, but less so than in *bellicosus*. Femora of all legs black, a feature at once distinguishing this from the other form. The more distal joints of first legs also black. Joints distad of femur in second legs yellowish, but patella and tibia with a black stripe along each side. In the third legs the patella and tibia are black or very dusky, the metatarsus with a black stripe along each side. In the fourth legs the patella is black, the tibia a little lighter, dusky, the metatarsus again black and the tarsus annulate at least at base.

Length, exclusive of chelicerae, 5.6 mm.

Type.— M. C. Z. 1,000.

Locality.— Philippines: Tayabas Island. One adult male, and one immature male.

Simonella simplex, sp. nov.

♀. Head yellow, the carapace otherwise a somewhat dusky brown; a narrow black stripe between eye of second and corresponding eye of fourth row on each side, this stripe interrupted behind the third eye. Sternum brown.

Palpi and legs I and II yellow, or the femora a little darkened. Coxa, trochanter and femur of leg III dusky brown or blackish, the distal joints yellow. Leg IV with femur and tibia blackish, the proximal and distal joints yellow. Dorsum and sides of abdomen dark, nearly black in front of the depression; similarly colored back of the depression, the posterior dark area extending in a median dorsal angle to the anterior dark area; yellow between the two dark areas; posterior dark area enclosing a pale chevron mark in its anterior portion and two more obscure paired pale marks behind this. Venter yellow behind genital furrow, brownish in front of it. The epigynum in general form similar to that of *S. decipiens* Cambridge but the plate is somewhat broadly produced behind at middle above the cavity though not so much so as in *S. bicolor*, and the process is emarginate at the middle.

Length, 5.6 mm.
TYPE.— M. C. Z. 1,318.
LOCALITY.— Guatemala: Los Amates. One female.

SAITIS CANALIS, sp. nov.

♂. The tegument of the carapace is dusky brown behind, with the eye-region black and showing purple and green reflections. The hair of the thoracic region yellowish gray; eye-region above rubbed bare in type, but toward eyes of second row with flattened appressed hairs or scales of a green color and in some lights showing violet reflections; a band of similar green scales down face to between anterior median eyes. Clypeus densely clothed with yellowish gray hair. Patella, tibia, and tarsus of palpus above with greenish scales, and similar scales also present on the legs. First and second legs with femur, patella, tibia, and metatarsus clothed with conspicuously long black hair, this especially developed on the femora dorsally and on tibiae ventrally. The abdomen blackish above with a median dorsal light stripe ending in a point behind some distance in front of spinnerets, this light stripe densely clothed with light yellowish gray hair. Tibial apophysis of palpus simple, pointed, slightly curved; stylus at distal end toward inner side of bulb, short and simple, but little sinuate.

Length, 4 mm.
TYPE.— M. C. Z. 1,319.
LOCALITY.— Barro Colorado Island. W. C. Allee. One male.

DENDRYPHANTES VIRGINIS, sp. nov.

♂. This species is close to *D. flavipedes* Peckhams and has probably been confused with it in considerable measure. As in *flavipedes* the embolus in the male palpus is furcate, presenting two branches distad; of these branches the outer one is longer and more slender and is curved beyond apex of the inner,

stouter and straighter process. In the present species the outer, curved process is much more slender and almost bristle-like and by this character it may be distinguished at once from the northern *D. flavipedes*. This species is apparently the form from Lakehurst, N. J., referred by Emerton doubtfully to *flavipides* in Bull. Amer. mus. nat. hist., 1913, **32**, p. 259, pl. 45, fig. 10.

Type.— M. C. Z. 1,320.

Localities.— Maryland; D.C.; Virginia; North Carolina; New Jersey.

As the males from all these places agree fully in the characteristic above noted, there seems no room for doubt that they represent a species distinct from *flavipedes*.

Dendryphantes atopodon, sp. nov.

♂. Tegument of carapace chestnut, the eyes on black, clothed principally with long white scales. Sternum chestnut. Femora of legs black except proximally where yellow. Patellae and tibiae of all legs also solid black except that patellae tend to be more or less yellow proximally and the tibia in an incomplete median annulus and somewhat along dorsal surface. Metatarsus I black except in a proximal ring, II and III dark at ends and IV along sides, otherwise yellow like the tarsi. Patella, tibia, and tarsus of the palpus black. Dorsum of abdomen with a band of white hair across each anterolateral corner and back on each side to near spinnerets. The species is characterized by having a single laminate tooth somewhat concave at distal end on lower margin of chelicera. Tibia I with three pairs of spines beneath, metatarsus I with two pairs beneath and none on sides. The palpal organ suggests that of *D. capitatus*, the terminal process of bulb being of much the same form.

Length, 3 mm.

Type.— M. C. Z. 1,325.

Locality.— Virginia: Scott's Run, July. One adult male and two immature females.

This species is undoubtedly closely related to *D. capitatus*. The latter, however, is a larger form in which the anterior process of the palpal organ has its ectal branch decidedly longer and more curved. The tooth of chelicera in *capitatus* is also flattened and approaches the form shown in the present species.

SOLPUGIDA.

Solpugidae.

Solpuga matabelena, sp. nov.

Color in dried specimen mostly uniform light brown or yellowish, dorsal plates of abdomen darker, and fingers of chelicerae chestnut proximally and black distally. Malleoli uniform brown. Upper finger of chelicera with a single small tooth between the two principal teeth, this contiguous with base of the caudal principal tooth, the two principal teeth not widely separated. Metatarsus of leg II dorsally with only the series of usual short spines. Metatarsus of palpus with numerous stout setae below, this of ordinary form and color. Metatarsus III with five spines in the dorsal series, the third of these but slightly beyond middle. Tarsus IV with seven segments which taken together nearly equal the metatarsus in length. Cephalothorax a little wider than length of tibia of palpus.

Length, about 45 mm.

Type.— M. C. Z. 1,326.

Locality.— Africa: Matabele Land. One specimen.

Suggests the South African *S. venator* Pocock, but may be distinguished in having the cephalothorax wider than length of tibia of palpus and the third spine of metatarsus III at middle instead of notably distad of it.

Ammotrecha pseustes, sp. nov.

Chelicerae lemon-yellow, the fingers brownish. Cephalothorax a darker, more orange-yellow. Eye-tubercle black, divided by a pale, though in part somewhat obscure, median paler line. The abdomen has a median longitudinal pale stripe as in *stolli* Pocock and *tabogana* Chamberlin, this bordered on each side with a series of chocolate-brown spots; sides darkened, of violaceous cast; venter paler. Femur of palpi dark except at proximal end; tibia, metatarsus, and tarsus dark throughout excepting apex of tarsus. First legs yellow throughout or the femur, tibia and metatarsus slightly smoky or violaceous. Second legs similar in color to the first but the violaceous tinge of the joints mentioned somewhat more pronounced. In the third and fourth legs the femur is dark above and laterally and the tibia and metatarsus are darkened excepting at the distal end. Eyes three fourths their diameter apart. Anterior margin of eye-tubercle with two longer setae borne on tubercles and several shorter hairs. Metatarsus of palpus bearing on each ventral edge a series of three smooth, short, cylindrical spines resembling the cylindrical setae except in being stouter; cylindrical setae not numerous. A few cylindri-

eal setae on ventral surface of tibia. Upper finger of chelicera with three large teeth beyond the proximal small ones; between the first and second of these large teeth a small one. A single small tooth between the two large teeth of the movable finger.

Length, exclusive of chelicerae, 13 mm.

Type.— M. C. Z. 1,327.

Locality.— Canal Zone: Remo Island, Largo. 31 August, 1923. Zetek and Molino in nest of the termite *Kalotermes marginipennis* (Latreille), "acting like the soldiers."

This species is related to *A. stolli* Pocock and *A. tabogana* Chamberlin, but may be distinguished readily in having only three small spines in each series on ventral surface of metatarsus of palpus.

Eremobates tejonus, sp. nov.

♂. Dorsal finger of chelicera without teeth, but with a continuous ventral edge which is convexly rounded distad of middle where finger narrows and is a little curved; dorsal edge of this finger a little incurved near middle. The movable finger of chelicera has near proximal fourth of length a single large tooth and near middle a large but broad and low obtuse swelling or tooth between which and the principal tooth is a denticle, the latter free from base of large tooth; ventral edge notched or indented near beginning of distal third. On the surface between fingers of chelicera are four stout teeth; the two uppermost of these equal and in a transverse line, and the other two in line below the outer of these, the lowest tooth smaller than the others and the middle one stouter than the two upper ones.

Length, about 10 mm.

Type.— M. C. Z. 1,328.

Locality.— California: Fort Tejon. One male from stomach of toad.

PSEUDOSCORPIONIDA.

Cheliferidae.

Chelodamus, gen. nov.

Fingers of palpi with accessory teeth. Palpi rather slender, approaching the Chelifer type; femur clavate, widest toward distal end; tibia with a narrow neck proximally beyond which it widens suddenly and is then of nearly uniform width to distal end, not at all subfusiform as in typical Chelanops; chela long and slender, the fingers slender and gaping. Flagellum of three setae, of the usual Chelifer type. Carapace as wide as or wider than long; with two

deep transverse furrows; eye-spots absent or obscure. Legs in general as in Chelanops; claws smooth. Abdomen broad and flattened; tergites not divided at median line but with a broad, paler, less strongly chitinized longitudinal band across all but the eleventh tergite, this band a little depressed. A somewhat similar band along venter.

GENOTYPE.— *Chelodamus atopus*, sp. nov.

In addition to the two species described as new, the genus also includes *Chelifer mirabilis* Banks.

CHELODAMUS ATOPUS, sp. nov.

♂. The flagellum consists of three hairs of which the proximal two are simple and pointed, the first being shortest, the second intermediate in length; the distal seta is broader and longer, pointed and curved distally, and is dentate along anterior margin. Spinneret slender, acuminate, with four short processes or branches along the abaxial margin, one of which processes is bifid nearly to its base. Claws of leg IV wholly smooth. Carapace of same width across caudal border as long; narrowing forward from caudal end, more strongly so in front of the anterior groove, rounding in to outer edges of chelicerae between which the margin is nearly straight. The two transverse furrows deep and conspicuous, the anterior one bowed forward at middle, half way between ends of carapace. Surface densely finely granular. A paler area or eye-spot on border just ectad of base of each chelicera, the area flattened and no lens defined. Abdomen elliptic in outline, widest at sixth segment, a little more than one and two fifths times longer than the greatest width. Surface densely finely granular. Setae in the row along posterior border eighteen to twenty in number. Endites smooth. Trochanter of palpus strongly pedicillate, three fourths as thick as long. Femur narrow at proximal end from where, as seen from above, it widens gradually to distal end as usual in Chelifer; the joint four times longer than thick. Tibia with a rather long, somewhat pedicillate, proximal stalk beyond which it widens strongly and subclavately to middle and then narrows a little to distal end; three times longer than thick; shorter than the femur. Chela as a whole decidedly longer than the femur or tibia, its hand alone being equal to or slightly longer than the tibia. Hand 2.9 times longer than thick. Fingers slender and curved, shorter than the hand. Accessory teeth present on both fingers; on the movable finger there are, in the female allotype, twelve accessory teeth in the outer series and five stouter ones in the inner series.

Length, 4.54 mm. Carapace 1.45 mm. long, of equal breadth. Abdomen 3 mm. long by 2.18 mm. wide. Trochanter of palpus .81 × .58 mm.; femur, 1.9 × .41 mm.; tibia 1.7 × .54 mm.; chela as whole 2.9 mm. × .58 mm.; hand, 1.7 mm. long.

TYPE.— M. C. Z. 1,329.

LOCALITY.— Costa Rica.

Chelodamus mexicolens, sp. nov.

♂. Twenty-one teeth in exterior serrula of chelicera. Spinneret (galea) in type with tip broken off but showing three exterior processes on the part remaining; of these the most proximal is much nearer the base than is the corresponding one in *atopus;* the second process from base simple, not bifid as in *atopus.* The anterior seta of flagellum fimbriate practically to the tip whereas in *atopus* there is a considerable length at tip that has margin smooth, this smooth portion being notably curved. Accessory teeth on inner side of movable finger of chela eleven in number; of these the five most proximal ones are closer together than are the more distal ones. Accessory teeth of exterior series on the same finger smaller, evenly spaced, and thirteen in number. Carapace in general form and appearance as in *atopus,* but a little broader at base in proportion to length (9.8). Surface densely finely granular. Eyespots obscure. Abdomen more badly elliptic, the width at sixth segment being to length as 29:33. Palpi in general similar in form to those of the genotype but with differences in details; *e.g.,* the tibia is straight distally instead of being a little incurved distally as viewed from above and thus as a whole appearing to have a weakly sigmoidal outline.

Total length, 4.43 mm. Cephalothorax 1.45 mm. long by 1.63 mm. wide at base. Abdomen 3 mm. × 1.63 mm. Trochanter of palpus. .76 × .47 mm. Femur 1.7 × .43 mm. Tibia 1.45 × .43 mm. Chela 2.77 mm. long; hand 1.49 × .54 mm.; finger 1.37 mm. long by .23 mm. thick at base.

Type.— M. C. Z. 1,330.

Locality.— Mexico: Guadalajara.

Chelanops consocius, sp. nov.

♂. Two distinct white eye spots at anterior margin, the lens-area scarcely convex, granular. Surface of carapace in general smooth; setae sparse, a definite transverse series of them on caudal border. Carapace crossed by two furrows of which the posterior one is long and gently recurved; the anterior one is very short and is also weakly recurved. Carapace very nearly as wide across base as the length. Abdomen oblong, somewhat broader at base than at middle or posterior end and longer than wide at base in ration 22:13. Tergites all longitudinally divided. The usual series of setae across posterior border of each tergite, these acuminate and finely pointed, not at all clavate, about twenty on first tergite, fewer in an irregular anterior series. In the chelicera the spinneret is a short simple papilla greatly exceeded by the terminal hair as well as by the apex of the finger. In the pedipalpus the endite is roughly triangular, with lateral angle rounded, surface smooth. Other joints with a few apparently bacillar hairs but most hairs pointed and none clavate. Trochanter and femur pedicillate, the joints beyond pedicel abruptly and

strongly thickened. Tibia broadly subfusiform but more strongly narrowed at base where it is somewhat pedicillate. The chela as a whole is a little over two and two fifths times its greatest width; the fingers short and thick, shorter than the hand (22:49). Palpi much longer than body. Tactile hair on tarsus IV about one fifth length from base.

Length 2.33 mm. Cephalothorax 1 mm. long, .9 mm. wide. Abdomen 1.33 mm. long by .9 mm. wide at base. Trochanter of palpus .5 × .3 mm.; femur, .83 × .43 mm.; tibia, .9 × .43 mm.; chela 1.6 mm. × .66 mm.; the fingers .73 mm. long, the movable one only four times longer than thick and the immovable one still thicker. Femur IV, .83 × .33 mm.; tibia .66 × .18 mm.; tarsus .48 × .11 mm.

Type.— M. C. Z. 1,331.

Locality.— Barro Colorado Island. In a log with *Amitermes beaumonti* (Banks) and *Nasutitermes conigera* (Motschulsky). Zetek and Molino. One male.

Olpium isolatum, sp. nov.

♀. Carapace but little longer than wide (9:8); with a transverse band, which is not conspicuous, about one third the length from caudal edge; widest at level of this band, from where gently narrowed forward to eyes and back to caudal end; anterior eyes removed from front margin by about their diameter; width across anterior end to greatest width about as 1:2. Abdomen long; widest near middle of length and narrowing toward both ends; tergites in length corresponding to this form, being longest at middle of abdomen, the longest being to the first one as 50:33, none divided. Chelicerae with spinneret (galea) long, translucent, divided distally into three slender branches. Trochanter of palpus strongly widening above a narrow base, four fifths as wide as long; femur subpedicillate, rapidly widening above a narrow base, but of uniform thickness over most of the length, 2.6 times longer than thick; tibia with the usual narrow basal part, clearly thicker than femur, moderately narrowed from middle to distal end; chela, when viewed at right angles to its broadest surface, with sides of hand nearly parallel; hand longer than wide (3:2) and longer than fingers (15:11).

Length, 2.76 mm. Cephalothorax .6 × .53 mm. Abdomen 2.16 × 1 mm. Trochanter of palpus, .25 × .2 mm.; femur, .56 × .21 mm.; tibia .56 × .26 mm.; chela .96 × .35 mm., its hand .5 × .35 mm., the fingers .36 mm. long.

Type.— M. C. Z. 1,332.

Locality.— Canal Zone: Remo Island, Largo. Zetek and Molino. One female with Kalotermes sp. and Prorhinotermes sp.

The specimen had been allowed to dry and this may have somewhat altered some of the proportions.

PHALANGIDA.

Cosmetidae.

Meterginoides eutypa, sp. nov.

This, the second species referred to the genus, is separable from the genotype at a glance in its much longer legs and more pronounced coloring. The dorsum is a dark ferruginous brown, with a bright yellow band on each side of scutum which encloses some brown spots; the middle area with three longitudinal rows of yellow spots, those of the middle series being larger than the others. Legs appearing light brown, under the lens showing a fine net-work of dark lines and dots over a yellowish background. Venter ferruginous. Eye-tubercle broad, depressed, only slightly elevated above general level, smooth. All areas of dorsal scutum smooth. First joint of chelicera moderately enlarged, dorsally tuberculate especially at anterior and posterior ends. Joints of legs, in female, wholly smooth. Tarsus I in holotype with seven joints, II with seventeen, III with ten and IV with eleven.

Length, 7.5 mm.; femur IV, 10 mm.

Type.— M. C. Z. 1,333.

Locality.— Barro Colorado Island. W. C. Allee. One female.

Kevonones, gen. nov.

Third and fourth legs stouter than those of the anterior pairs. Abdominal scutum wholly lacking paired tubercles or spines on any of its areas, the surface throughout covered with granules or small conical tubercles of uniform size. Free segments of abdomen with transverse series of small tubercles. Tarsus I composed of five articles, III and IV of six articles each.

Genotype.— *Erginus mexicanus* Banks.

The types of *K. mexicanus* (M. C. Z. 1,354) were taken at San Jose del Cabo, Lower California.

Cynorta discreta, sp. nov.

Body dorsally a dark chocolate-brown somewhat paler beneath. A yellowish white V-shaped mark at first dorsal sulcus; from this mark a line of the same color runs back on the mid-dorsal line to join the apex of a similarly colored delta-shaped outline behind tubercles of area III; a light line on each side also connects the anterior V-mark and the posterior delta, this lateral line sending out a short spur laterally near its caudal end. The legs are yellowish, the proximal joints with numerous black marks which on tibia and metatarsus are more clearly annuliform, the annuli not developed on a varying distal

portion of metatarsus. Eye-tubercle obviously wider from side to side than long anteroposteriorly; bearing several granules toward each eye. First abdominal area of dorsal scutum with the usual pair of rounded tubercles. Third area of scutum with two spines stout and conical, smooth. Tarsus I with six segments; II with twelve segments; II with eight; and IV with nine.

TYPE.— M. C. Z. 1,334.
LOCALITY.— Barro Colorado Island. W. C. Allee. Two females.

CYNORTA PLEURALIS, sp. nov.

Appearance and structure in general as in *discreta*, but a smaller form with relatively longer femur IV readily distinguishable by differences in the white markings of the dorsum. There is a net-work of white lines between the lateral longitudinal line on each side and the margin of the scutum and the line across caudal border is widely interrupted at the middle. The caudal side or base of the delta-formed outline is also slightly interrupted at the middle. The legs are marked similarly to those of *discreta* but in general are lighter. Spines of area III of abdominal scutum well separated, erect and acute. Tarsus I with six articles; II with twelve; III with eight; and IV with nine.

Length, 4 mm.; femur IV, 7 mm.
TYPE.— M. C. Z. 1,336.
LOCALITY.— Barro Colorado Island. W. C. Allee. One female.

CYNORTA DIDYMA, sp. nov.

A form closely resembling *C. discreta* and *C. pleuralis* in general appearance, but easily distinguishable by differences in the details of the pattern of white lines on the dorsum. There is no lateral net-work such as is present in *pleuralis*. The inner branch at anterior end of each arm of the anterior V is more slender than in that species; the lateral longitudinal line just before uniting with the V forms almost a right angle and sends forward a short spur from the angle; the lateral line is more sinuous than in *pleuralis* and the lateral spur from its caudal end extends all the way to the margin of the scutum; and there are other differences in lesser details of the pattern. Legs as in the other species. Tarsus I with six articles; II with fifteen; III with eight; and IV with ten.

Length, 4.5 mm.; femur IV, 7 mm.
TYPE.— M. C. Z. 1,337.
LOCALITY.— Barro Colorado Island. W. C. Allee. Two specimens.

CYNORTA CONFLUENS, sp. nov.

Body dark chocolate colored or blackish above, the cephalothoracic part somewhat lighter and the venter and coxae of legs somewhat ferruginous. The dorsal scutum with a wide V-shaped white mark at first sulcus, each arm of the

V breaking into a net-work each side of the eye-tubercle; a median longitudinal line of same color and one on each side as in *discreta* but these connected by three transverse lines in front of the tubercles of area III, behind which the median line does not extend; the lateral longitudinal lines also connected by a transverse line behind the tubercles; two light spurs running from posterior end of lateral line on each side ectad to margin of scutum; near caudal margin of scutum a transverse white line and a similar one may be seen on each of the first two free abdominal segments. Legs yellow with black dots and rings; tibia I annulate at base, II nearly to distal end, III to near middle, and IV well toward distal end; femora with numerous dark markings but these not arranged in distinct annuli; the tarsi more uniformly dark. Eye-tubercle low, somewhat depressed at middle, clearly wider than anteroposterior length, with a few granules toward each eye. Paired tubercles of first abdominal area of scutum inconspicuous. The conical spines of area III short and conical and confluent with each other at base and in this contrasting with the preceding species in which the spines are widely separated. Tarsus I with six articles, II with twelve or thirteen, III with eight or nine and IV also with eight or nine.

Length, 5 mm.; femur IV, 5.6 mm.

Type.— M. C. Z. 1,339.

Locality.— Barro Colorado Island. W. C. Allee. Three females.

Cynorta nannocornuta, sp. nov.

This species differs from the others here described in the greatly reduced spines of area II of the scutum, these being scarcely more than conical tubercles. The tubercles of area I present but also small. Eye-tubercle low and wide, depressed at the middle. Dorsum blackish, ferruginous in an area on each side and along each lateral border. Venter also more ferruginous. Legs with dark markings small and more obscure, and the annuli distinct only on the metatarsi. The white lines on dorsum form a pattern in outline somewhat like that of *confluens* but with the lateral longitudinal line on each side obliterated excepting at ends; the transverse line in front of spines of area III almost obliterated, broken into a series of spots; a spot on median line between spines representing the continuation of the median white line; a caudally directed spur from anterior end of each arm of the anterior V-mark; the latter the most heavily developed part of the pattern. Tarsus I with six articles; II with sixteen; III with eight; IV with nine or ten.

Length, 5 mm.; tibia IV, 6 mm.

Type.— M. C. Z. 1,341.

Locality.— Barro Colorado Island. W. C. Allee. One specimen.

The posterior legs rather stouter than usual. The species suggests Flirtea; but in the absence of a male the question raised by its peculiarities cannot be settled.

Gonyleptidae.

Zygopachylus, gen. nov.

Eye-tumulus widely separated from anterior margin, wide and low, unarmed but bearing a few setigerous tubercles near each eye. Dorsal scutum obviously widest near third area but somewhat approaching the prostygnine type. Scutum crossed by five transverse furrows of which the first two are united by a median longitudinal sulcus. Area III of abdominal scutum bearing a pair of stout spines or horns, otherwise unarmed. The free segment of abdomen also with a pair of stout spines. First joint of chelicera with a narrow basal portion above which it is strongly clavately enlarged. Palpus shorter than the body; femur armed at apex within. Second joint of tarsus three-jointed. Tarsi I, III, and IV six-jointed.

Genotype.— *Zygopachylus albomarginis*, sp. nov.

Zygopachylus albomarginis, sp. nov.

Body and legs dark ferruginous, almost black except the marginal tubercles which are bright white, and the tips of the processes on area III. Eye-tumulus near middle of cephalothorax, much wider than long, low, unarmed except for several small tubercles toward each eye. A few widely separated, small, rounded tubercles on each abdominal area. Each lateral margin of dorsal scutum bearing a series of nearly contiguous, distally rounded, white tubercles of which the next to the most caudal, which is at end of area IV, greatly exceeds the others in size. Legs with minute setigerous granules, those of coxae beneath, as of abdomen, larger. Tarsus I with six joints, II with twelve and III and IV with six.

Length, 4 mm.; femur IV, 5 mm.
Type.— M. C. Z. 1,342.
Locality.— Barro Colorado Island. One specimen.

Nesopachylus, gen. nov.

With a distinctly elevated eye-tumulus which typically bears a pair of ordinary setigerous tubercles like those elsewhere on body and legs, but with no true spinous processes. Dorsal scutum with five transverse furrows of which the first two are united by a median longitudinal furrow. Scutum abruptly widened, rounding out convexly, between the first and fourth furrows. None of the areas of the abdominal scutum bearing enlarged single or paired tubercles or spines, simply with transverse rows of uniform tubercles. First free abdominal segment unarmed, the second with a stout median process or spine. Femur of palpus not armed at apex within. Posterior legs much stouter than

the anterior ones. Tarsus I with five articles, III and IV each with six. Pseudonychium distinct, slender, the claws smooth.

GENOTYPE.— *Nesopachylus monoceros*, sp. nov.

NESOPACHYLUS MONOCEROS, sp. nov.

General color of body and legs dark ferruginous. Eye-tumulus separated from anterior margin of carapace by nearly its length; transversely broadly elliptic in outline; conspicuously elevated between the eyes and bearing apically the two setigerous tubercles, otherwise smooth. A conspicuous transverse sulcus in front of eye-tumulus setting off anterior border of carapace. A stout tubercle or short ridge at margin laterad from eye-tumulus on each side. A submarginal depression setting off the border on each side of abdominal scutum, each border bearing a longitudinal series of tubercles posteriorly. Each area of abdominal scutum with a transverse series of setigerous tubercles. First two free abdominal segments with a similar series of setigerous tubercles but these rather larger and on the second one the median tubercle is greatly enlarged and elongate. On the third free segment the median tubercle is also enlarged but is rounded, not elongate or spiniform. Venter with numerous setigerous tubercles. Legs with all joints excepting tarsi bearing setigerous tubercles similar to those of body. Palpi much shorter than body; femur with a series of setigerous tubercles along ventral line but with no spines; tibia ventrally along inner edge with two long and two short spinous processes and with two along outer edge, the following joint with two processes on each edge.

Length, 10 mm.; femur IV, 5 mm.; femur II same length as femur IV.
TYPE.— M. C. Z. 1,343.
LOCALITY.— Barro Colorado Island. Three males.

PHALANGODIDAE.

ETHOBUNUS, gen. nov.

Eyes elevated on a common tumulus which is distinctly removed from anterior margin of cephalothorax and bears near each eye an erect conical tubercle. Dorsal scutum with five transverse furrows. Areas I and II of abdominal portion of scutum each bearing a pair of widely separated conical processes. First two free segments of abdomen unarmed, the third with a pair of processes similar to those of the scutum. First joint of chelicerae slender proximally, at distal end abruptly thickened and elevated. Femur, patella, tibia, and tarsus of palpus armed. Legs slender and of moderate length. Second tarsus of leg I two-jointed; of III three-jointed. Third and fourth tarsi without pseudonychium and scopula.

GENOTYPE.— *Ethobunus simplex*, sp. nov.

Ethobunus simplex, sp. nov.

Body dusky ferruginous; the legs similarly colored, somewhat lighter distally. Scutum widening from level of first furrow to that of second, then of uniform width to caudal end, or widening a little. Surface of scutum granular but without enlarged tubercles excepting the large paired ones and a few smaller ones on lateral margin. Femur of legs I and II with a few setigerous granules, the surface being very small, the granules on other legs obsolete. Coxa of palpus with a longer and a short tubercle below; femur with two low spinous processes below toward base and a shorter tubercle farther distad, patella with one spine below; tibia with two spines below at outer edge and two at inner; tarsus also with two spines on each edge. Tarsus I with three joints, II with eight, III with five and IV with six.

Length, 3 mm.; femur IV, 4 mm.

Type.— M. C. Z. 1,345.

Locality.— Barro Colorado Island. One specimen. W. C. Allee.

Zygobunus, gen. nov.

No common eye-tumulus whatsoever; the eyes not elevated, widely separated from each other and from the front margin, directed laterad; no processes between eyes. Dorsal scutum with four transverse furrows of which the third and fourth are deepest, the second in particular appearing typically weak and not connected with the first by a median longitudinal sulcus. Cephalothorax narrowest behind eyes from where the scutum widens moderately to the caudal corners. None of the dorsal areas of scutum and neither free abdominal segments nor the anal plate armed with spines or processes. Coxa IV much longer and thicker than III, widely visible from above. First joint of chelicera very long, much more slender than the second. Palpi longer than body; femur unarmed; the tibia and tarsus with spinous processes on ventral margins. First, second, and fourth tarsi more than six-jointed; tarsus III six-jointed. Tarsal claws wholly smooth.

Genotype.— *Zygobunus barronus*, sp. nov.

Zygobunus barronus, sp. nov.

Body above dusky or blackish over ferruginous, paler beneath, the free segments of abdomen darkest. Legs dusky over yellowish, paler distally. Eyes nearly twice as far from each other as from the nearest part of anterior margin and farther from each other than from the lateral margin on each side, each on a black base. Surface of dorsum in general densely covered with granules most of which bear short, caudally directed setae; the free segments of abdomen similarly clothed. First joint of mandibles bearing on sides more ele-

vated, teeth-like tubercles which are more numerous on outer side; on dorsal surface several tubercles proximally, one at distal end, and at middle a much longer, horn-like process. Second joint of mandible with numerous smaller setigerous granules or low tubercles. Coxae of palpi long, bearing tubercles on inner surface, particularly along upper margin similar to those of first joint of mandible but smaller; second joint with an elevated tubercle dorsally and three smaller ones in middle line below; femur with four large tubercles on median line toward base below. Coxa IV stouter than the first three; all densely covered with setigerous tubercles like those of dorsum. Other joints of legs proximad of metatarsus bearing numerous setigerous granules. Legs short. Tarsus I with seven joints; II with twelve; III with six; and IV with seven.

Length, 5 mm.; femur IV, 3.2 mm.

Type.— M. C. Z. 1,346.

Locality.— Barro Colorado Island. W. C. Allee. One specimen.

Phalangiidae.

Protolophus dixiensis, sp. nov.

♀. Resembles *singularis* in having the paired dorsal humps of the abdomen bearing several teeth. It is a somewhat smaller form than that species with longer and more slender legs and may be easily distinguished by its lighter more grayish coloration and particularly by its conspicuously mottled and annulate legs, the legs of *singularis* being uniform and dark or at most with longitudinal lines but not at all mottled. Abdomen mottled with numerous partly confluent whitish spots, these forming a distinctly lighter transverse band behind the last pair of humps. The venter of abdomen with light markings at sides. Coxae uniform gray, not spotted. Femur of palpus with white marks at distal end, the patella with such marks above, and the tibia at base and at distal end; tip of tarsus black. Inner apophysis of patella of palpus long and straight, more densely setose at distal end where it is dusky; the tibial apophysis short and rounded, also densely setose and dusky. Femur of palpus with conspicuous spinous points below; patella with few; tibia with a few below, mostly proximally; tarsus with none. Tibia II has three false sutures, or also a fourth indistinct one.

♂. Smaller and lighter than the female, but the color and color-markings similar. The dorsal abdominal humps similarly spiniferous. It differs from other known species conspicuously in the form of the palpus. The apophysis of the patella is present as in the female but is scarcely longer than thick and the tibial apophysis is a simple rounded protuberance. The tibia is thickened and presents a low swelling ventrally proximad of middle and over the mesal side of and distad of this swelling the joint is densely hairy, the hairs being very short. The tarsus of palpus has two longitudinal series of spinous points

on its ventral side and the preceding joints are also armed with stout, non-seriate points.

Length of female, 7 mm.; femur I, 4 mm.; II, 6.5 mm.; IV, 5.8 mm.

Length of male, 5.3 mm.; femur I, 3.5 mm.; femur II, 6 mm.; femur IV, 5.8 mm.

Type.— M. C. Z. 1,347.

Locality.— Utah: Washington Co., Zion National Park. May, 1924.

This species stands apart from the two previously known in having tibia II with three or four false joints instead of 1 or 0, in not having the chelicerae of male specially enlarged, and in the form of the male palpus as above noted.

Prionostemma duplex, sp. nov.

Body elliptic in outline, pointed behind, strongly convexly elevated above. Body prevailingly brown or blackish brown behind middle where crossed by a white stripe in front of which the color is much lighter to anterior end, though this anterior region has some brown markings; the posterior half may embrace some light spots. Proximal joints of palpus brownish, the tarsus yellow. Chelicerae yellow. Venter and coxae of legs yellow. Legs in general dark brown; tibia II whitish at distal end, and metatarsus II whitish at the adjacent proximal end. Tarsus palpus obviously longer than tibia plus patella; patella at distal end on inner side with a short, rounded apophysis; femur with spinous points at distal end above, the dorsal surface proximally smooth or nearly so, but the points numerous over ventral surface; tibia and patella with numerous spinous points above as well as below. Eye-tubercle smooth, strongly constricted at base, with a median longitudinal furrow between eyes.

Length, 4.8 mm.; femur I, 10.5 mm.; femur II, 18 mm.; femur IV, 13 mm. Length of leg I, 45 mm.; of leg II, 92 mm.

Type.— M. C. Z. 1,349.

Locality.— Barro Colorado Island. Sixteen specimens. W. C. Allee.

Prionostemma simplex, sp. nov.

Most of the dorsum is light, mottled with brown, the last few abdominal segments darker, blackish, but no abrupt separation between an anterior light and a posterior dark region. Yellowish below, but the coxae with weakly brownish areas, especially distally. Legs dark brown. Tibia of second legs white at distal end. Chelicerae yellow on distal half, brown proximally; femur and patella brown with yellow areas below and at tip. Tarsus of palpus

longer than tibia plus patella; patella with a long, finger-like apophysis within at distal end, in this contrasting obviously with *duplex;* joints clothed with ordinary short setae but without any truly spinous points. Eye-tubercle smooth, constricted at base.

Length, 3.25 mm.; femur I, 6 mm.; femur II, 13 mm.; femur IV, 8 mm.

Type.— M. C. Z. 1,351.

Locality.— Barro Colorado Island. W. C. Allee. Three specimens.

A somewhat smaller form than *duplex* with shorter legs and at once distinguishable from that species by the presence of the finger-like apophysis on the patella.

JUL 31 1925

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LXVII. No. 5.

BURMEISTER'S PORPOISE (PHOCAENA SPINIPINNIS).

By Glover M. Allen.

With Four Plates.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
July, 1925.

No. 5.— *Burmeister's Porpoise* (*Phocaena spinipinnis*).

By Glover M. Allen.

In 1872, Louis Agassiz undertook a voyage around the continent of South America on the ship Hassler for the purpose of zoölogical investigation. No detailed account of this expedition was ever printed, but the collections made under Agassiz's inspiring leadership were large and valuable. While the vessel was at anchor in the harbor of Payta, northern Peru, a porpoise was obtained, the head, flukes, pectorals, and dorsal fin of which were preserved in alcohol entire, while the remainder of the axial skeleton was cleaned for permanent keeping. This specimen I have lately had an opportunity to study and find that it represents Burmeister's Porpoise, *Phocaena spinipinnis*, a species of which apparently but three other specimens are known. True (1889) in his review of the Delphinidae felt no doubt as to its distinctness from *P. phocaena*, basing his opinion on Burmeister's (1865) account, and added: "It is probable that the skeleton of this species when known will be found to differ considerably from that of *P. communis* [= *phocaena*]," a surmise which is fully warranted.

History.

The species was first made known by Burmeister in 1865 who based his description on a specimen in the Museo Nacional at Buenos Aires, that had been captured at the mouth of the La Plata River a few years before his appointment as director of that Museum. Recognizing its peculiarities, he had the skull extracted from the mounted skin and published rough figures of it with his description. In a subsequent paper (1869) he gave a figure of the exterior taken from the mounted specimen, together with fairly good drawings of the skull. The exterior view shows a distinct beak, a feature which is without doubt unnatural, due to faulty taxidermy. The peculiar shape of the dorsal fin and its prominent denticles are, however, fairly well represented. In 1917, Gallardo published a brief account of the same specimen, with a photographic view of it as then remounted in an attempt to render its outlines more nearly correct. The result is doubtless an improvement, though it was not to be expected that the contours, especially of the head, should be wholly accurate without an actual specimen as a pattern.

No additional information concerning this porpoise was published

until 1893, when Dr. R. A. Philippi of the National Museum of Chile, in a paper on Los delfines de la punta austral de la América del Sur, included under the new name *Phocaena philippii* a brief description sent him by Dr. Pérez Canto, of what is undoubtedly the same species. The sketch of the exterior supplied by the latter is also reproduced (Philippi, 1893, pl. 3, fig. 2) and, although somewhat conventionalized, shows fairly well the characteristic outline of the dorsal fin, reclining and with a *convex* posterior outline. The description was later reprinted by Pérez Canto (1896) under his own authorship. In a second paper, Philippi (1896) mentions that the skull of this specimen is preserved at Valparaiso, Chile, where it was examined by his son, Friedrich Philippi. He adds also, under the name *Acanthodelphis philippii*, an account of a third specimen captured in March, 1894, in the Bay of Talcahuano, Chile, and figures the exterior and the skull. Although he recognized the similarity of these two specimens to Burmeister's *Phocaena spinipinnis*, he continued to regard them as of a distinct species on account of their lacking the beak and the caudal keels shown in the latter's figure. These supposed differences, as pointed out by True (1903) are certainly fallacious. The sketches of the cranium given in Philippi's later paper further confirm the identity of *Phocaena philippii* with *P. spinipinnis*, while the outline of the exterior, though somewhat conventionalized, is a great improvement over previous figures.

So far as known to me, no other examples of this porpoise have been recorded. Its skeleton, except the skull, has remained unknown, and no accurate figures of its exterior have been published. These notes on the Payta specimen, apparently the fourth to be recorded, will therefore serve partly to fill this gap. Nothing is known of its habits, but like the Common Porpoise (*Phocaena phocaena*) it probably frequents the shallower waters in pursuit of fish. All four specimens were captured in harbors: Burmeister's type in the La Plata estuary, Pérez Canto's example in the harbor of Valparaiso, Philippi's in the Bay of Talcahuano, and the Hassler's in the harbor of Payta (as I am informed by the only member of the expedition now living, Mr. J. Henry Blake, who recalls the circumstances clearly). The four specimens probably indicate very nearly the range of the species: *viz.*, in the cooler waters off the South American coast from the La Plata region, around Cape Horn, and northward in the Humboldt Current to northern Peru, a range closely similar to that of several other marine vertebrates as shown by Dr. R. C. Murphy (1923).

The synonymy of the species follows:

PHOCAENA SPINIPINNIS Burmeister.

Phocaena spinipinnis Burmeister, Proc. Zool. soc. London, 1865, p. 228; Ann. mag. nat. hist., 1865, ser. 3, **16**, p. 132.
Phocaena philippii Pérez Canto, in Philippi, Anal. Mus. nac. Chile, Santiago, sect. 1, zool., 1893, no. 6, p. 9, pl. 3, fig. 2.
Acanthodelphis (*Phocaena*) *philippii* Pérez Canto, in Philippi, Anal. Mus. nac. Chile, Santiago, sect. 1, zool., 1896, no. 12, p. 8, pl. 2–3.
Phocaena spinipennis Trouessart, Cat. Mamm., 1898, **2**, pt. 5, p. 1043.

EXTERNAL CHARACTERS.

Color.— The color of Burmeister's specimen could not be determined from the mounted skin. Pérez Canto (1896), however, who had a freshly killed example, described it as very dark greenish black all over, while Philippi (1896) refers to the Talcahuano specimen as a uniform shining black all over like a well-polished shoe, except for a very narrow white mid-ventral line. The furrow at the insertion of the pectoral limbs is also white. His account is perhaps the more nearly accurate.

Form.— The head as seen from above in the M. C. Z. specimen (Plate **1**, fig. 1) tapers regularly to a blunt tip as in the common Harbor Porpoise (*Phocaena phocaena*); but the profile is less rounded, with a slight depression above the eye, giving the appearance of a distinct hump over the base of the rostrum (due possibly in part to the shrinking in alcohol of the nasal chamber). In front of this the outline falls more sharply away to the tip of the snout. The lower jaw projects a trifle beyond the upper. In the figure (Plate **1**, fig. 2) a white pointer shows the position of the external ear opening, about as far behind the eye as the eye is behind the angle of the mouth. The blowhole is about over the eye with the usual crescentic outline, concavity forward. A comparison of the profile view with Burmeister's (1869) figure, shows that in his mounted specimen the skin of the rostrum had shrunk so as to be concave where it should be convex. This defect in the mounting of the type-specimen has since been partially corrected (Gallardo, 1917). The outlines as published by Philippi (1893) are on the other hand probably too evenly convex. The head of the M. C. Z. specimen measured as follows:

Snout to corner of blowhole	150 mm.
" " eye	143
" " corner of mouth (on perpendicular)	95

Gape, snout to corner of mouth	107 mm.
" chin " " " "	112
Corner of mouth to eye	64
Distance across corners of mouth	110

The flukes (Plate **2**, fig. 2) show no peculiarities. Their posterior border is slightly and evenly concave, the median notch V-shaped. There is no distinct keel to the caudal peduncle, such as Philippi had inferred from Burmeister's drawing.

The pectoral fin (Plate **2**, fig. 3) has a slightly convex anterior outline and a blunt rounded tip, below which the posterior outline is slightly concave, then bows outward to the widest part near the base. The pectoral of *Phocaena phocaena* is similar in general outline, but is proportionally smaller.

Very characteristic is the outline of the dorsal fin (Plate **2**, fig. 1), which, instead of being high, convex in front, and concave behind, as in the latter species, is low and reclining, with a blunt tip and very slightly *convex* posterior border. The horny denticles on its anterior edge have been described by Burmeister and by Philippi. They seem characteristic of the species and their presence is perhaps more constant than in *P. phocaena*, in which they are less developed and may apparently be quite absent. If, as believed by Kükenthal, these represent the vestiges of a dermal armor, their more usual retention in *P. spinipinnis* is a primitive character.

Size.— Burmeister (1865) records the length of the mounted type-skin as 1,620 mm. (Gallardo gives it as 1,680, remounted). He believed the specimen a young one but in this was doubtless mistaken, for though perhaps not fully adult, it was probably nearly full size. Philippi (1896) gives the length of the Talcahuano specimen as 1,850 mm., but since this measurement was taken following the curves of the back, it is doubtless too large. The total length of the Payta skeleton when in position is about 1,565 mm., and as this is nearly adult judging from the condition of the bones and their epiphyses, it is probable that 1,600 mm. is not far from adult size.

Skeleton.

In the following account of the skeleton, I have made comparison throughout with *Phocaena phocaena* only. Of the other known species of the genus, *P. relicta* of the Black Sea probably is closely similar to this latter; *Phocaena dalli* True is placed by Andrews in the genus Phocaenoides; *Phocaena vomerina* of the Pacific is now regarded

as identical with *P. phocaena*; while *P. dioptrica* Lahille is still imperfectly known. It may be added here, that Philippi's *Phocaena obtusata* is almost certainly a female of this last, and his name should with little doubt replace *dioptrica*. His figure shows a similar form, with the same enormous dorsal fin, and the sharply defined white belly. The vertical bars of white shown are probably due to the folding of the skin in packing, for the consequent squeezing of the oily hide often results in producing whitish markings, and he distinctly states that it was received in poor condition, with the epidermis gone in places. The statement that the pectoral fin was black is the only important discrepancy, for in *P. dioptrica* as originally described, this is white. Possibly, however, since Philippi's specimen was in a far from fresh condition, this portion had discolored, or there may be individual variation in this respect.

Skull.— In general form the skull of *P. spinipinnis* (Plate **3**) resembles that of *P. phocaena*, with the pointed rostrum, and the peculiar knobs at the base of the intermaxillaries. Its most obvious difference is in the much lesser compression of the brain-case from front to back, so that the supraoccipital, forming the back of the cranium, is not nearly so erect but slants forward and its upper part bends over so as to be parallel with the plane of the palate. Where it meets the frontals at the vertex there is a wide boss formed by the thickened median parts, much wider and thicker than the vertex of *P. phocaena*. This lesser degree of compression shows also in the generally lower forehead, while the maxillaries and frontals show a much less upward deflection. In *P. phocaena* the proximal ends of the maxillaries are much more expanded. Laterally they reach the edge of the orbit and spread back over the frontals to within a centimeter of their posterior edge and almost to the border of the temporal fossa. In *P. spinipinnis* they are less developed, do not extend back so far, nor do they quite reach the edge of the orbit, but bend sharply in at the anterior corner of the temporal fossa leaving the frontal exposed to a width of some 25 mm. at the widest.

Directly in front of the knobs at the base of the rostrum, the intermaxillaries are flattened in *P. phocaena*, whereas in *P. spinipinnis* they curve strongly up, continuing the convex surface of the rostrum. Their posterior ends reach to the middle of the blowhole in both, but those of *spinipinnis* are much the narrower.

In rear view the skull of the latter is obviously not so high, in correlation with its lesser degree of fore-and-aft compression. Its occipital condyles, however, are of absolutely greater area.

The palatal aspect of the skull is much the same in both species. The vomer appears as a lozenge-shaped area, about 44 mm. long, in the anterior second quarter of the middle line. The pterygoids are separate and proportionally wider across than in *P. phocaena;* and the basisphenoid is very much wider. The jugal is less slender not so round and threadlike in section, but thickened and grooved anteriorly.

An important difference is that the teeth are much fewer in number and the tooth row does not extend back so far, though the dental groove continues some 20 mm. behind the last tooth in the maxillary. The intermaxillaries carry two teeth each, short spicules with bluntly pointed crowns that hardly pierce the gum. Each maxillary has 14 teeth with expanded and laterally compressed crowns, the posteriormost with two vertical grooves on the outer side. The lower jaw in the two species is much alike, but in *P. spinipinnis* the coronoid process is slightly more above the alveolar level. Its two anterior teeth, on each side, are small spicules like those of the upper jaw, while the others resemble the maxillary teeth except that the grooves are at the *inner* side in the more posterior ones. The teeth of the Payta specimen have their crowns much truncated by wear, and this apparently was the case also in Burmeister's specimen. Their total number is $\frac{16-16}{17-18}$. Burmeister records 16 on each side above and 17 below. Philippi notes 16 on each side of the upper jaw in the Talcahuano skull. The teeth in *P. phocaena* average about 26 on each side.

Measurements of the Skull of Phocaena spinipinnis.

Greatest length, tip of rostrum to condyles	273 mm.
Length from tip of rostrum to vertex of supraoccipital	215
" " " " " " back of maxillary	207
" " " " " " edge of blowhole	141
" " " " " " proximal end of intermaxillary	160
" " " " " " median spine of palate	152
" " " " " " maxillary notch	122
Length of tooth row (alveoli)	79
Greatest breadth across squamosal processes	153
" " " front of orbits	130
" " of rostrum at maxillary notches	83
" " " brain case across temporal fossae	127

Vertebrae.— Except for the skull, the skeleton of *P. spinipinnis* has till now remained unknown. It is interesting therefore to find that the vertebral column throughout differs very widely from that of *P. phocaena,* and in general shows a much less degree of specialization.

The number of vertebrae in the Payta specimen is slightly greater than the average in *P. phocaena* as shown by the following counts of specimens in the M. C. Z.

	Cervicals	*Dorsals*	*Lumbars*	*Caudals*	*Total*
P. spinipinnis	7	14	15	32	68
P. phocaena	7	13	13	31	64
P. phocaena	7	13	16	31	67

True (1889) gives the counts for several skeletons of *P. phocaena* showing a range in variation from 64 to 67.

Cervicals.— In the Payta specimen it is the first three cervicals only that are fused (Plate **4**, fig. 1), whereas in *P. phocaena* the *six* anterior vertebrae have become solidified into a single mass (Plate **4**, fig. 2) and at the same time have lost so much of their thickness, that the long dorsal spine of the atlas quite covers their neural spines, while its deeply notched tip embraces the well-developed spine of the seventh. In *P. spinipinnis* a much more primitive condition is retained; the neural spine of the atlas is shorter, the 4th to 7th vertebrae are without distinct dorsal spines, and have thicker (*i.e.* less reduced) centra, resulting in a distinctly longer neck, in correlation perhaps with the larger occipital condyles to give the head additional support.

As a progressive character in cetaceans the vertebrarterial canal formed by the lateral bony arches of the cervicals is in course of disappearance through the reduction of these arches. In *P. spinipinnis* the ventral half of the arch on cervicals 4, 5, 6, still persists in a well-developed condition, and is largest on the sixth vertebra. In *P. phocaena* these processes are so reduced that they may be quite absent on the 4th and 5th, and at most are but thin projections bent over forward instead of standing well out as stout knobs.

Dorsals.— The rib-bearing vertebrae in *P. phocaena* are usually 12 or 13. The 14 dorsals in *P. spinipinnis* may be unusual, but taken in connection with other less specialized characters, very likely indicate a slightly lesser degree of reduction in this species. A striking peculiarity of the series is that the spines of the first to fourth dorsals increase slightly but regularly in height, tapering to a blunt point in side view; the fifth is equal in height to the fourth, but the sixth is

lower and blunter. From this point back the spines increase in height again, reaching a maximum at about the fifth lumbar, after which they soon decline. All are tapering in side view and tip strongly backward, especially the more posterior (Plate **4**, fig. 4). The longer spines measure about 85 mm., their centra 27 mm. high. Quite different is the condition in *P. phocaena*. The spines of the seventh cervical and first dorsal are taper-pointed, but from here back, not only are they all about of a uniform breadth in profile from base to summit, but the last two or three dorsals and the succeeding vertebrae have their spines directed forward (Plate **4**, fig. 3) recalling the condition often seen in ungulates. This difference is altogether striking and characteristic.

In sundry other respects the vertebrae of *P. spinipinnis* seem less specialized than those of *P. phocaena*. In the latter the tubercular end of the lateral process is constricted off, beginning with the second or the third dorsal, while at the same time the front end of the constricting ridge becomes produced forward to a sharp point which increases regularly in length and migrates medially with successive vertebrae until at about the ninth dorsal the lateral tubercle is long and well marked off, while the pointed processes of opposite sides nearly meet at the base of the neural spine to form the V-shaped zygapophyses embracing the spine of the vertebra next in front. In *P. spinipinnis*, on the contrary, the tubercula are not distinctly marked off at the ends of the lateral processes, while the anterior points are very poorly developed as broadly triangular projections which on the three last dorsals and first and second (barely) lumbars are just large enough to articulate with the spine in front by fitting into depressions. On the 53d vertebra the dorsal spine becomes obsolete.

Of the chevron bones one or two appear to have been lost so that the exact number is not certain.

Ribs.— Of the fourteen pairs of ribs the last is very slender and practically floating, about 160 mm. long and without a distinct articular surface. The *eight* anterior ribs have both capitular and tubercular attachments, although the eighth rib on the *left* side has the capitular portion reduced to a small projection that probably did not extend to the centrum. The eighth rib of the *right* side, however, has a completely developed head.

In three skeletons of *P. phocaena* examined, one has *six* pairs of ribs with both capitular and tubercular attachments, while each of the two others has *seven* pairs, indicating probably a more reduced and specialized condition than in the South American species.

The shape of the ribs is also quite different in the two species. In *P. spinipinnis* the tubercle rises distinctly above the flattened dorsal shoulder of the rib and the capitular part tapers slightly from this point. In corresponding ribs of *P. phocaena*, however, the tubercular facet is cut sharply off from the upper contour of the rib in a nearly perpendicular plane and the capitular process, which begins at its lower edge, is longer and less tapering. Another very marked difference is that in *P. phocaena* the ribs are much narrower in the upper half or so of their curved portion, beyond which they expand gradually to the lower end, sometimes narrowing a little but yet maintaining a uniform breadth in the distal portion. In *P. spinipinnis* not only is the upper half of the curved portion absolutely broader than in corresponding ribs of *P. phocaena*, so that the expansion of the lower half is less marked, but the distal end, instead of maintaining its breadth, tapers decidedly in its last 25 or 30 mm.

Sternum.— The sternum of *P. spinipinnis* differs from that of *P. phocaena* in being less reduced. In the latter it is much broader in front than behind and is usually rather thinner, as a result of which there is a perforation in the midline, marking the point of union between the first and second pairs of sternebra. A deep notch at the posterior border further divides it, and there is sometimes a second perforation marking the division between the second and third pairs of sternebra. In contrast to this condition, the sternum of *P. spinipinnis* is much thickened throughout, the anterior segment is only a little wider than the others, and there are no perforations. The posterior margin is slightly concave but without the deep narrow notch of *P. phocaena*. In both species there are seven pairs of sternal ribs, four of which articulate directly with the sternum, or occasionally in *P. phocaena*, the fourth pair articulates through the mediation of two cartilaginous plates which form the hinder part of the sternum.

Fore limb.— The fore limb of *P. spinipinnis* is proportionally larger than that of *P. phocaena*, which is specialized through reduction in size. The scapula, though not very different in outline, is longer in proportion to its height, and the long acromion and coracoid process seem slightly more slender. The bones of the arm are similar to those of *P. phocaena* but much larger, the head and the tuberosity of the humerus nearly a third greater in areal extent. The phalangeal formula is apparently the same in both, namely, I 2, II 8, III 7, IV 4, V 2.

Summary.

Of Burmeister's Porpoise, four specimens are now known, all from the cooler waters of the South American littoral. The range of the species, as indicated by these examples, is probably confined to the area from the La Plata around Cape Horn to the Chilean and Peruvian coasts, following the Humboldt Current to northern Peru. Compared with the Common Harbor Porpoise (*P. phocaena*) its head has a less rounded profile, its pectorals are less reduced in size, and the dorsal fin is differently shaped, with more prominent horny tubercles. It is a much less specialized member of the genus, not only in these respects, but also in the following peculiarities of the skeleton:— the brain-case is less compressed, resulting in a flatter vertex, the jugal is better developed, there are fewer teeth and the tooth rows themselves are shorter; the number of vertebrae is slightly greater; the anterior *three* cervicals only are fused together instead of six, the cervicals have longer centra and no neural spines; the arches of the vertebrarterial canal are less reduced; there are 14 instead of 13 pairs of ribs; the neural spines of dorsal and lumbar vertebrae taper and are directed backward, instead of being broad at the tips and turned forward (in side view); the ribs are less specialized in shape and there is at least one additional pair with both tubercular and capitular articulations; finally, the limb bones are less reduced proportionately to the size of the animal, and the sternum is thicker, not so much widened in front, and has not developed the lacunae seen in that of *P. phocaena*. It is in every way a less specialized species.

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EXPLANATION OF PLATES.

PLATE 1.

PLATE 1.

Fig. 1.— *Phocaena spinipinnis*. Head from above, showing blowhole. Payta, Peru. ♀ about $\frac{1}{3}$.

Fig. 2.— The same in profile. The white pointer marks the external ear opening. ♀ about $\frac{1}{3}$.

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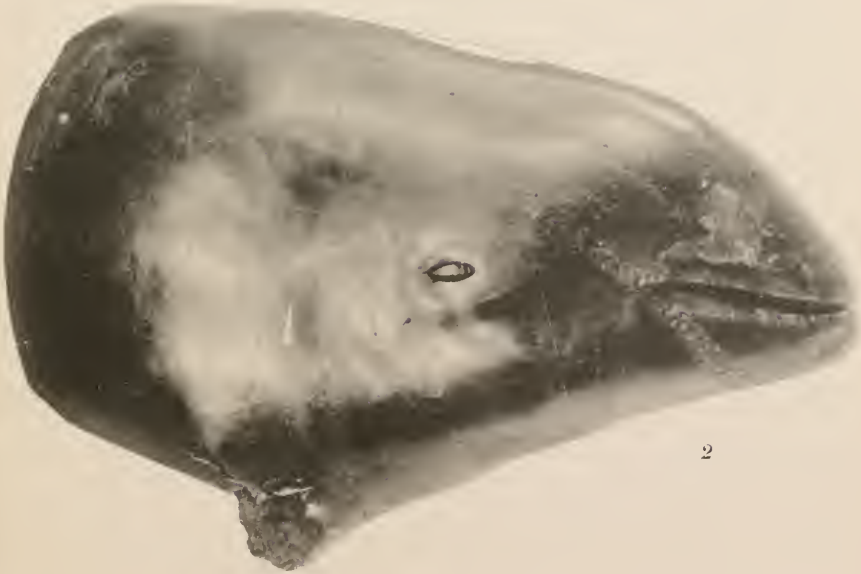

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PLATE 2.

PLATE 2.

Fig. 1.— *Phocaena spinipinnis*. Dorsal fin, side view, showing convex posterior border and the tuberculated anterior margin. Payta, Peru.
Fig. 2.— Flukes of same specimen.
Fig. 3.— Pectoral limb of same from below.

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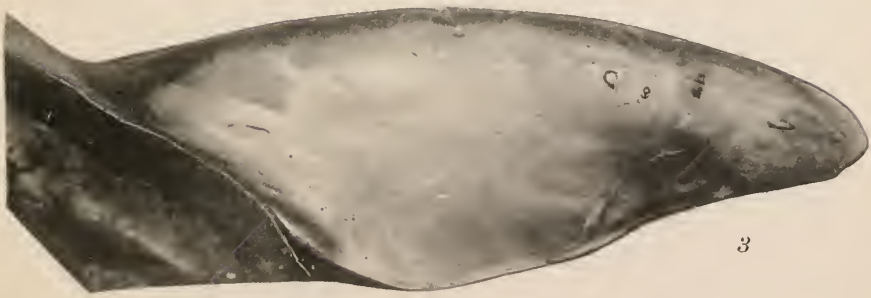

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PLATE 3.

PLATE 3.

Fig. 1.— *Phocaena spinipinnis*. Cranium from above. Payta, Peru. × about 0.4.
Fig. 2.— Same from the side. × about 0.4.
Fig. 3.— Same from below. × about 0.4.

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2
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PLATE 4.

PLATE 4.

Fig. 1.— *Phocaena spinipinnis.* Anterior end of vertebral column, showing cervicals and four dorsals. Payta, Peru.

Fig. 2.— *Phocaena phocaena.* Cervicals and five anterior dorsals. Massachusetts coast.

Fig. 3.— *Phocaena phocaena.* Portion of vertebral column, showing the neural spines turned forward (to the right). Same specimen.

Fig. 4.— *Phocaena spinipinnis.* Corresponding portion of vertebral column, showing neural spines turned backward (to the left).

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JUL 31 1925

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LXVII. No. 6.

DESCRIPTION OF A NEW PSITHYRUS, WITH AN ACCOUNT OF PSITHYRUS LABORIOSUS, AND NOTES ON BUMBLEBEES.

By Joseph Bequaert and Otto E. Plath.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
July, 1925.

No. 6.— *Description of a new Psithyrus, with an Account of Psithyrus laboriosus, and Notes on Bumblebees.*

By Joseph Bequaert and Otto E. Plath.

Introduction.

In the course of his biological studies of the New England Bremidae, the junior author has, during the last four years, bred and collected many hundreds of specimens of the several species occurring near Boston. A number of unusual color forms were thus brought to light, and it is the purpose of the present joint paper to discuss their taxonomic and biological significance.

Although Franklin, in his fundamental monograph has followed a different practice, we propose varietal names for several new color variants which seem well characterized, in order that they may be concisely and clearly referred to in general discussions. In some cases the distinction between two forms may also be of biological importance, as we shall endeavor to show for *Psithyrus laboriosus* and its variety *citrinus*. Franklin's main objection to naming the color varieties of bumblebees will be discussed later.

The types of the new forms are in the collection of the Museum of Comparative Zoölogy, Cambridge.

Description of a new Psithyrus from Oregon and California.

Psithyrus wheeleri, sp. nov.

Female.— Face black; occiput with yellow pile; thorax with the dorsum in front and the upper part of the pleura yellow, otherwise mostly dark; abdomen with the fourth tergite extensively yellow, otherwise dark.

Face entirely covered with black pile. Occiput with a triangular patch of pure yellow pile. Malar space about as long as wide at apex, about one fourth as long as the eye. Clypeus with a smooth space anteriorly, in the middle, otherwise densely punctate. Labrum with the basal tubercles low and rather inconspicuous. Apical margin of mandibles with a notch in the middle. Third and fifth antennal segments subequal in length, the fourth considerably shorter than either (Figure 1*a*). Dorsum of thorax anteriorly covered with yellow pile to the bases of the wings, the remainder black. The disk rather thinly clothed, but without bare patch. Mesopleura with yellow pile in the

upper part of the anterior portion only; the remainder of the sides and propodeum black. Fourth tergite of abdomen covered with yellow pile, except in the middle, where there is a somewhat triangular patch of black hairs, the apex of which reaches the hind margin. Remainder of abdomen with black hairs; the apex of the last segment with brownish ferruginous pubescence. The fifth tergite with extremely fine and much scattered punctures in the

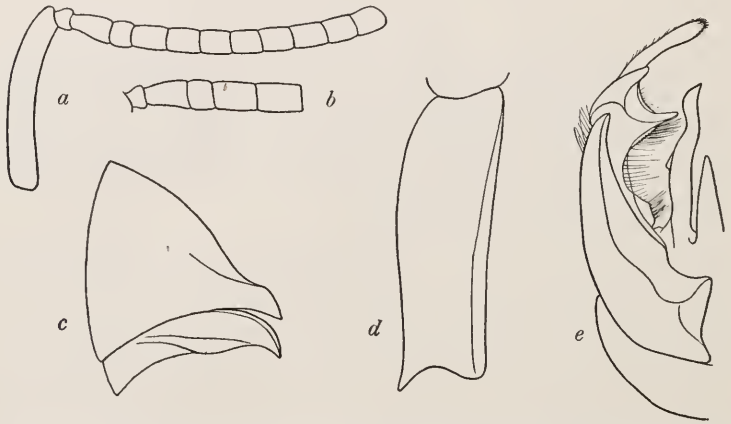

FIG. 1. *Psithyrus wheeleri* Bequaert and Plath. *a*, antenna of female; *b*, basal segments of male flagellum; *c*, apical tergite and sternite of female abdomen; *d*, hind metatarsus of female from the outer side; *e*, dorsal aspect of male genitalia.

middle, moderately punctate on the sides. The middle part of the exposed portion of the sixth tergite (epipygium) with very few and minute punctures or nearly impunctate, somewhat raised longitudinally into a faint ridge; the tergite slightly depressed before the apex, which is very pointed and narrow. Sixth sternite (hypopygium) extending much beyond the tergite, pointed and somewhat recurved at apex; the lateral carinae moderately and uniformly elevated throughout, ending much before the tip of the abdomen (Figure 1*c*). Wings much stained with brown, the fore pair darker in the region beyond the veins. Legs mostly black; the tarsi with some short ferruginous pubescence, especially on the posterior face of the hind metatarsi. Upper margin of hind tibiae and hind metatarsi with long hairs. Hind metatarsi three times as long as their greatest width, drawn out into a sharp and rather narrow point at the upper apex, the upper margin distinctly arcuate (Figure 1*d*).

Length of holotype, 15 mm.; length of fore wing, 14 mm.; (spread of wings, 34 mm.). Length of paratype, 13 mm.; length of fore wing, 13 mm.; (spread of wings, 31 mm.).

Male.— Face and clypeus entirely covered with black pile. Occiput with a large, triangular patch of yellow pile. Malar space about as long as wide at apex, about one fourth as long as the eye. Antennae with the third and fifth

segments subequal in length, the fourth shorter than either (Figure 1*b*); the flagellum nearly three times as long as the scape. Dorsum of thorax anteriorly covered with yellow pile to the bases of the wings, the remainder black. Mesopleura yellow only in the extreme upper part of the anterior portion; the remainder of sides and propodeum black. Fourth tergite of abdomen entirely covered with yellow pile; the fifth black, with a few yellow hairs on the extreme sides; the pile of the two last segments slightly ferruginous; the remainder of the abdomen black. Legs mostly dark; hairs fringing the hind tibiae and upper margin of hind metatarsi very long, as long as the width of the metatarsus. Branches of claspers of genitalia (Figure 1*e*) strongly pointed at tip dorsally; squamae bilobed, the inner lobe the longer and narrowly triangular in outline, the outer lobe short triangular and pointed at tip; volsellae very slender and somewhat more elongate than in *fernaldae;* sagitta shaped as in *fernaldae*, its shaft with a prominent tooth ventrally.

Length of allotype 14 mm. and paratype 15 mm.; length of fore wing 12.5 mm.; (spread of wings 30 mm.).

Holotype, M. C. Z. 15,280. Female, Oregon: Benton Co., Mary's Peak, July, 1916 (W. J. Chamberlin Coll.). Paratype. Female, Cala.: Sierra Nevada, (Edwards Coll.). Allotype and paratype. Males, Cala.: Alta Meadow, Sequoia National Park, 9,000 ft., August 23, 1917. (Cornell University Biological Expedition, W. M. Wheeler Coll.).

In Franklin's key (1912, p. 449–451) both sexes of this new species run to *P. crawfordi* and they were at first believed to be that species. *Psithyrus crawfordi*, however, belongs to the *laboriosus* group; while *P. wheeleri* possesses all the morphological features of the *fernaldae* group, including those pointed out in a later paper by Franklin (1915, p. 416). In coloration *P. wheeleri* is strikingly unlike *P. fernaldae*, of which we have examined six males and eleven females. Moreover, there are some structural differences, such as the shape of the hind metatarsus in the female and certain details of the male genitalia, so that we feel justified in regarding *wheeleri* as a distinct species and not merely as a color variation of *fernaldae*.

The two sexes of *P. wheeleri* are colored much alike, which is somewhat unusual in Psithyrus. There can hardly be any doubt that they are conspecific, although they were not taken together. They are remarkably similar to queens, workers, and males of *Bremus vosnesenskii* (Radoszkowsky) and *B. californicus* (Smith), both of which occur in California and Oregon. Probably *B. vosnesenskii* is the host of *P. wheeleri*, since it was by far the more common of the two at Alta Meadow. So great is the resemblance of *P. wheeleri* with the male and female of *B. vosnesenskii*, that our specimens were at first confused with that species.

The two Races of Psithyrus laboriosus (Fabricius).

Franklin (1912, p. 451) united with *laboriosus* Fabricius, based upon a female, the males described as *Apathus citrinus* Smith and *Apathus contiguus* Cresson, although, as far as he knew, they had not been taken *in coitu* or together in the nests of Bremus. On September 7, 1921, the junior author bred a female of *laboriosus* from a nest of *Bremus vagans*, in which a similar Psithyrus female had been found laying eggs on August 10 (Plath, 1922*a*, p. 29–31). In a later paper (Plath, 1922*b*, p. 195–197) he also recorded finding Psithyrus of the *laboriosus* group in nests of *Bremus vagans* and *B. impatiens*, males and females having been bred in each case. He pointed out that the males and females reared from the *B. impatiens* nest were different from those obtained from the nest of *B. vagans*. In 1923 and 1924 additional specimens of both sexes were found in other nests of these two species of Bremus.

An examination of this extensive material, comprising thirty-four females and seventy-five males, obtained from eight nests of Bremus, shows that they all belong to the species *Psithyrus laboriosus* in Franklin's sense. Yet they are rather easily arranged into two groups, based upon the color of the pile, each of the two types being restricted to one species of Bremus.

1. Psithyrus laboriosus (Fabricius). Typical form.

Fabricius's (1804, p. 352) original description of *Bombus laboriosus* was based upon a female and reads as follows: —

"B. thorace villoso cinereo, corpore atro immaculato. Habitat in Carolina Mus. Dom. Bosc. Statura praecedentium. Corpus totum atrum thorace solo pilis dorsi cinereis hirto. Alae obscurae. Pedes nigri."

This type of female, with the abdomen entirely covered with black pile or occasionally with a touch of yellow on the extreme sides of the third tergite (as mentioned in Cresson's description, 1863, p. 111), was obtained by us from the nests of *Bremus impatiens*. The corresponding males, found in the same nests, agree with Cresson's description (1863, p. 112) of *contiguus*:—

"*Male.* Head black, yellowish on the vertex. Thorax lemon-yellow, more or less black between the wings. Wings fusco-hyaline. Legs black, tarsi pale, inner side of the basal joint rufous. Abdomen with the first two segments

above lemon-yellow; rest black. Beneath black. Length 7–8 lines. *Variety.* The anterior portion of the second abdominal segment above mixed with black, especially on the sides."

It should be added that in certain specimens the third tergite of the abdomen shows a faint admixture of yellow in the anterior corners.

2. Psithyrus laboriosus (Fabricius) var. citrinus (Smith).

Smith (1854, p. 385) describes *Apathus citrinus* as follows: —

"Male. Length 6½ lines.— Black, the face densely clothed with long black pubescence; on the vertex it is obscurely yellow. Thorax thinly clothed above with long lemon-coloured pubescence, having a black band between the wings; the wings fusco-hyaline, slightly clouded at their apical margins; the sides of the thorax have a yellow pubescence, but beneath and also on the legs it is black. Abdomen, the three basal segments clothed with lemon-coloured pubescence, the apical ones with black; beneath black. *Hab.* United States."

This type of male, with the three first tergites entirely or mostly covered with yellow pile, was bred or obtained from nests of *Bremus vagans*. In some males the fourth tergite also shows an admixture of yellow hairs, especially in the extreme anterior corners. A specimen with this coloration was described by Cresson (1863, p. 112) as a possible variety of *citrinus*. From the same nests of *B. vagans* were obtained females which differ from those of typical *laboriosus* in having the pile of the third abdominal tergite extensively or wholly yellow instead of black. In some specimens the hind margin of the second tergite has a narrow fringe of yellow hairs on the sides, while there is a patch of yellow pile on the extreme corners of the first tergite also, and a strong admixture of yellow hairs between the ocelli and the base of the antennae. No name appears to have been proposed for this particular type of female, which should henceforth be known as that of the var. *citrinus*.

In view of our observations that typical *laboriosus* generally breeds in nests of *Bremus impatiens*, while the var. *citrinus* selects those of *Bremus vagans*, we have been at great pains to discover possible morphological differences between the two forms, but without result. A careful comparison of the male genitalia discloses no differences; but it should be kept in mind that these are always slight, and perhaps not quite reliable, between the several species of the *laboriosus* group. On the average the females of typical *laboriosus* are slightly smaller than those of the var. *citrinus*.

Occasionally one may find in a *B. vagans* nest a male of the *contiguus* type and *vice versa*, a male of the *citrinus* type in a nest of *B. impatiens*. These may possibly be stray males that have reached the nest from outside. However, we find also in both nests among the males a number of intermediate forms, which it is possible to arrange in a series leading from typical *laboriosus* to the var. *citrinus*.

The following analysis of the several nests, condensed in the Table below, shows the proportions of the different color types in each case.

Nests of Bremus vagans. — (1) Nest of August 10, 1921, with a female *citrinus*. Another female, also of the var. *citrinus*, was bred on September 7.

TABLE.

	Nests of *Bremus vagans*				Nests of *Bremus impatiens*			
	1	2	3	4	5	6	7	8
Psithyrus laboriosus.								
Females: typical	—	—	—	—	1	1	—	18
with touch of yellow on tergite 3	—	—	—	—	4	—	2	—
var. *citrinus*	2	6	—	—	—	—	—	—
Males: with mixture of yellow and black on tergite 2	—	—	—	—	1	—	—	1
typical	—	—	—	—	7	3	1	7
with touch of yellow on tergite 3	—	1	1	—	5	1	—	1
var. *citrinus*, with mixture of yellow and black on tergite 3	—	10	4	—	—	—	1	3
var. *citrinus*	—	7	9	8	—	3	—	1

(2) Nest of June 26, 1922, containing a *citrinus* female when taken. Later five females, all of the var. *citrinus* were found in it, and eighteen males, divided as follows: — seven *citrinus;* six *citrinus*, with a slight admixture of black hairs on the third tergite; four *citrinus*, with a larger amount of black on the third tergite; one typical *laboriosus*, with but few yellow hairs at extreme anterior corners of third tergite.

(3) Nest of August 4, 1923. Of fourteen males obtained, nine are of the var. *citrinus:* four show a mixture in various proportions of black and yellow hairs on the third tergite; and one is typical *laboriosus* with a trace of yellow in the corners of the third tergite.

(4) Nest of July 27, 1923. The eight males obtained are all of the var. *citrinus.*

Nests of Bremus impatiens.— (5) Nest of August 8, 1922, containing one female and two males of typical *laboriosus,* when taken. From this nest were obtained four females nearly typical *laboriosus* and eleven males which may be called *laboriosus,* although the extent of black pile on the abdomen varies a great deal; in five specimens the third tergite is wholly black, but the second and even the first shows an admixture of black hairs; in one of them the abdomen is almost wholly black, with a few yellow hairs on the first tergite; the five remaining males are like the so-called "*laboriosus*" of *Bremus vagans* nests, that is with a few yellow hairs in the corners of the third tergite.

(6) Nest of July 30, 1923. In this were found later, one female of typical *laboriosus* and seven males, of which three are typical *laboriosus,* one is *laboriosus* with some admixture of yellow pile on the sides of the third tergite, and three are of the var. *citrinus.*

(7) Nest of July 31, 1924. From this were bred, in September, two female *laboriosus* with a touch of yellow pile on the sides of the third tergite; and two males, one typical *laboriosus,* the other with a mixture of black and yellow pile on third tergite.

(8) Nest of August 13, 1924. From this were later obtained eighteen females, all typical *laboriosus,* and thirteen males divided as follows: — seven typical; one *laboriosus* with a few yellow hairs on sides of the third tergite, and another *laboriosus* with much black pile mixed with the yellow on the second tergite; three with a mixture of yellow and black pile on the third tergite; one of the var. *citrinus.*

Franklin's treatment of *laboriosus* and *citrinus* masks the interesting biological fact that each of these two forms shows a decided preference for a particular species of bumblebee. Owing to the absence of structural differences and the occurrence of occasional intergrades, especially among the males, we could not, however, regard them as distinct species. It may well be argued that they should be ranked as races or subspecies. Unfortunately there is no agreement among systematists concerning the concept of "race." In the case under discussion, the two forms are certainly not geographical races, since they occur in the same locality and have on the whole the same distribution. Perhaps they might be regarded as

biological races. For the present we shall call *citrinus* a variety of *laboriosus*.

As known at present, the distribution of the two forms is as follows:

1. *Psithyrus laboriosus* (Fabricius), typical form (= *contiguus* Cresson). Cresson described *contiguus* from Connecticut, Pennsylvania, and Delaware. We have seen specimens from Maine (Brunswick, Bar Harbor, and South West Harbor, Mt. Desert). Vermont (Bennington, Chittenden). Massachusetts (Sherborn, Wellesley, Brookline, Forest Hills, Auburndale, Manomet, Stony Brook, Blue Hills Reservation). Connecticut (Colebrook). New York (Port Maitland, Yarmouth Co., Ithaca, Otto, Kings Park, Springs, Long Island). Maryland (Plummer Island). Virginia (Glencarlyn). Texas (Dallas).

A small male of Forest Hills (total length, 10 mm.) represents an extreme melanistic form, in which only the first tergite is covered with pale yellow hairs; the second tergite as well as the remainder of the abdomen are exclusively black pilose. The genitalia of this specimen are exactly like those of typical *laboriosus*.

2. *Psithyrus laboriosus* var. *citrinus* (Smith). Cresson records it from Massachusetts, Connecticut, New York, and Illinois. We have seen specimens from Nova Scotia, Maine (Bar Harbor, and South West Harbor, Mt. Desert). Vermont (Grand Isle, Chittenden). New Hampshire (Camp Asquam, Squam Lake). Massachusetts (Wellesley, Brookline, Forest Hills). Connecticut (Colebrook). New York (Huntington, and Wyandanch, Long Island, Ithaca), and Pennsylvania (Pottstown).

Two females from Vermont represent an extreme variation in which the face has a considerable amount of yellow pile, forming a transverse band below the ocelli and a small tuft above the clypeus; the first tergite not only has the sides wholly covered with yellow hairs, but these extend over the middle along the apical margin; second tergite black, with a very broad apical yellow margin, slightly widened on the sides; third tergite entirely pure yellow; fourth tergite black, with a tuft of yellow hairs on the extreme sides. Due to the abundance of yellow pile amidst the black hairs of the face, these specimens run to *P. insularis* in Franklin's key (1912, p. 450). They differ, however, from *insularis* in having the dorsum of the thorax wholly covered with yellow pile. We were at first inclined to propose a varietal name for this rather striking color variant, but having found a series of gradations connecting it with *citrinus*, we regard it as an extreme variation of that form.

Miscellaneous Notes on Psithyrus.

Psithyrus fernaldae Franklin.

This species is apparently common at Colebrook, Connecticut, where Professor Wheeler took nine females in June and July, 1911. In the same locality he obtained four males of *P. tricolor* Franklin during July, 1911, and another in 1922. This further confirms that *fernaldae* and *tricolor* are the two sexes of one species, as was suggested by Franklin (1912, p. 475) and more definitely by Frison (1923, p. 321 and 1924, p. 295). The collection of the Boston Society of Natural History also contains specimens from Maine (Machias, and Bar Harbor, Mt. Desert), New Hampshire (Halfway House, Mt. Washington, 4,000 ft.), Massachusetts (Coldbrook Springs).

An additional character, not mentioned by Franklin, is found in the labrum of the female: the basal tubercles are rather inconspicuous, forming low ridges which are not angular toward the middle line. In *P. wheeleri* they are similarly formed and, since they are very prominent and triangular in the other species which we have examined (*laboriosus, insularis, variabilis, latitarsus,* and *ashtoni*), we believe that this character might be used for the *fernaldae* group as a whole. In the European *P. globosus* Eversmann, which Franklin places in the *fernaldae* group, the basal tubercles of the labrum are also quite low.

Psithyrus crawfordi Franklin.

We have seen a male from Alta Meadow, California, 9,000 ft., August 23, 1917 (W. M. Wheeler Coll.) and another from Truckee, California, August 4, 1914 (L. Bruner Coll.), which agree quite well, in coloration, with Franklin's description of *P. crawfordi.* The fifth antennal segment is distinctly longer than the third, the third slightly longer than the fourth (Figure 2*a*). The genitalia were apparently not examined by Franklin. In our specimens (Figure 2*b*) they show the main characteristics of the *laboriosus* group: — claspers with their branches broadly rounded at the end (dorsally), somewhat more projecting at apex than in *laboriosus;* squamae broadly bilobate, the lobes about equal in size, obtusely pointed and hardly different from those of *laboriosus;* volsellae in general outline like those of *laboriosus.*

We also surmise that the host of *P. crawfordi* is either *Bremus vosnesenskii* or *B. californicus,* since the similarity in coloration is

equally striking as in the case of *P. wheeleri*. In collections males of *P. crawfordi* or *P. wheeleri* have undoubtedly been confused with those of the above-named species of Bremus.

FIG. 2. *Psithyrus crawfordi* Franklin. *a*, basal segments of male flagellum; *b*, dorsal aspect of male genitalia.

Psithyrus ashtoni (Cresson).

In two former papers, the junior author has recorded *Bremus affinis* (Cresson) as the host of this Psithyrus (Plath, 1922*a*, p. 26 and 1922*b*, p. 191).

On July 15, 1924, a female of *P. ashtoni* was found living in a colony of *Bremus terricola* (Kirby), kept in an observation box and consisting of about twenty-five workers, a dozen young queens and several males. This female of *P. ashtoni* was left unmolested in the colony, a good indication that *B. terricola* also might be its host; for the junior author has observed on several occasions that, if a female of *Psithyrus laboriosus* enters a *B. terricola* colony, it is attacked and killed. Later the association of *P. ashtoni* with *B. terricola* was confirmed by the following observation. On August 8, 1924, the junior author found in a plowed field, at Forest Hills, a nest of *B. terricola* containing three workers, three young females of *P. ashtoni*, and several *P. ashtoni* males and females which had died in the cocoons before hatching.

Psithyrus suckleyi (Greene).

The collection of the Museum of Comparative Zoölogy contains a male from Umatilla, Oregon, (S. Henshaw Coll.) and two females

(*latitarsus* Morrill) from Bridger Basin, Wyoming (S. Garman Coll.); also a female from Tolland, Colorado, on Frasera, July, 1915 (L. A. Kenoyer Coll.; received from Prof. T. D. A. Cockerell). We have also seen three males from Mary's Peak, Benton Co., Oregon (W. J. Chamberlin Coll.).

Psithyrus insularis (Smith).

Colorado: Tolland, 1 female, on Pentstemon, July, 1915 (L. A. Kenoyer Coll.; received from Prof. T. D. A. Cockerell). Mus. Comp. Zoöl.

New York: Keene Valley, 1 male (*consultus* Franklin), September 7, 1917 (H. Notman Coll.).

Some Varieties of Bremus from the Vicinity of Boston.

Bremus separatus var. **nero**, var. nov.

Worker.— Differs from typical *separatus* in the presence of a considerable amount of rufous pile on the fourth abdominal tergite, forming a transverse band, which covers about the posterior half of the segment; the band is notched in the middle, where there is a small patch of black hairs. The second tergite is almost entirely covered with brownish yellow pile.

Length 15 mm.; length of fore wing 11 mm.; (spread of wings 26 mm.).

The only specimen (M. C. Z. 15,279) seen is fully colored and was taken at Forest Hills (O. E. Plath Coll.).

Bremus bimaculatus var. **ahenus**, var. nov.

Queen.— Head and thorax as in typical *bimaculatus*. First tergite of abdomen covered with yellow pile; second tergite with a short, basal, middle patch of yellow pile, covering about one third of the width, a small patch of black hairs in the extreme anterior corners, the remainder of the tergite bright rufous; third tergite covered with bright rufous pile, a few black hairs near the anterior margin, especially at the sides; remaining tergites and all sternites with black hair. Legs with black pile, but the corbicular fringes bright rufous.

Length 19 mm.; length of fore wing 15 mm.; (spread of wings 36 mm.).

Male.— Head and thorax as in typical *bimaculatus*. First tergite of abdomen with yellow pile; second tergite mostly yellow, with a small, round patch of black hairs on the sides near the anterior margin; the posterior margin covered with rufous hairs, narrowly in the middle, quite broadly on the sides; third tergite mostly with rufous pile, a small patch of black hairs anteriorly on the sides; remainder of dorsum black; venter mostly covered with light pile. Legs as in typical *bimaculatus*.

In a second male the rufous of the second and third tergites is distributed in a similar manner, but much less bright.

Length 12 to 13 mm.; length of fore wing 12 mm.; (spread of wings 28 mm.).

The queen (holotype M. C. Z. 15,281) was found in a nest of typical *B. bimaculatus* kept in an observation box and originally taken at Forest Hills. The two males (allotype and paratype) were taken July 23, 1924, hovering about a nest of *B. bimaculatus* situated in a stone wall at Forest Hills (O. E. Plath Coll.).

Bremus bimaculatus var. **arboreti**, var. nov.

Queen.— Head entirely covered with black pile; a few pale hairs on sides of occiput. Thorax with anterior third and hind margin of dorsum as well as scutellum covered with yellow pile, these two areas sharply separated by a broad, black, interalar band; pleura bearing yellow pile nearly to the base of the legs; sides of median segment and under side of thorax black. Abdomen with first tergite bearing only yellow pile; second tergite with a very few yellow hairs in the center, close to the anterior margin; the remaining tergites and all the sternites black. Legs with black pile only.

Length 13 mm.; length of fore wing 15 mm.; (spread of wings 35 mm.).

The queen (holotype M. C. Z. 15,282) was taken June 2, 1924, by the junior author, in the Arnold Arboretum, at Forest Hills, Mass. It was evidently looking for a nesting site; kept in an observation box with some workers of typical *B. bimaculatus*, it laid eggs, but died June 14.

The coloration of this specimen is so aberrant that we were in doubt for some time concerning its relationship. It possesses, however, all the structural characters of *B. bimaculatus* and we feel quite certain that it belongs to that species. It is readily distinguished from the typical form by the black occiput and the broad, black, interalar band. Franklin (1912, p. 306) only mentions that in *bimaculatus* the occiput sometimes has "a very strong admixture of black hairs," while on the dorsum of the thorax the black hairs of the disk are occasionally "slightly suggestive of a black interalar band."

Bremus vagans var. **coctus**, var. nov.

Queen.— Differs from typical *vagans* in the third, fourth, and fifth abdominal tergites being mostly pale russet, instead of black. There is a rather strong admixture of yellow hairs about the bases of the antennae, but this is often found in typical *vagans*.

Length 14 mm.; length of fore wing 14 mm.; (spread of wings 32.5 mm.).

Male.— Head, thorax, and legs as in typical *vagans*. Abdomen of allotype with first and second tergites entirely covered with yellow pile; third with black pile; fourth mostly black, with an admixture of russet hairs posteriorly; fifth and sixth entirely covered with bright russet hairs; seventh black; venter mostly clothed with yellow pile. In the paratype, the sixth and seventh tergites are entirely covered with russet; the fifth is mostly black, with a few russet hairs in the apical half; third and fourth entirely black.

Length of allotype 13 mm. and of paratype 11 mm.; length of fore wing 12 and 10 mm.; (spread of wings 28 and 24 mm.).

The holotype (M. C. Z. 15,283) is a queen from Lahaway, Ocean Co., New Jersey, May 30, 1916 (J. Bequaert Coll.). The allotype a male from Forest Hills, Massachusetts (O. E. Plath Coll.); the paratype male is from Flushing, Long Island, New York (G. Engelhardt Coll.).

Franklin mentions no variation of *B. vagans* in which the black pile is replaced by russet. Of the several color variants which he describes we have seen specimens of the following: —

Color Variant 1. Queen and worker with only the basal portion of the second tergite covered with yellow pile. Lahaway, Ocean Co., New Jersey, May 30, 1916, 1 ♀, on *Robinia pseudo-acacia* (J. Bequaert Coll.). Oakdale, Long Island, New York, June, 1919, 1 ♀ (E. L. Bell Coll.).

Color Variant 2. Queen and worker with the extreme side margins of third and fourth tergites bearing yellow hair and fifth tergite entirely yellow. Ramsey, New Jersey, 1 ♀, on *Pedicularis canadensis*, June 4, 1916 (J. Bequaert Coll.). The corresponding male appears to be Franklin's *Male Color Variant* 2, of which we have seen several specimens from Big Indian, Catskill Mountains, New York and Chittenden, Vermont (J. Bequaert Coll.).

Male Color Variant 1. Third tergite with strong admixture of yellow pile, though still distinctly darker than the second. Upper Ausable Lake and Keene Valley, Essex Co., New York; and Chittenden, Vermont (J. Bequaert Coll.).

B. vagans subsp. *sandersoni* Franklin. Queen with pile of finer texture and malar space not longer than its width at apex. Chittenden, Vermont, August 15, 1916 (J. Bequaert Coll.).

According to Franklin, in certain queens of western Ontario, Assiniboia, Alberta, and Montana, the disk of the mesonotum shows enough black hairs to form a somewhat indefinite dark interalar band. We have, however, seen a series of workers and one male of *vagans* from the Adirondacks, New York, in which the black interalar band is quite pronounced. These specimens were taken at Upper Ausable

Lake, July 30, 1920 (♀ ♂); Mt. Marcy, 5,300 ft., July 21, 1920 (♀); and Mt. Skylight, 4,900 ft., July 22, 1920 (♀), on *Vaccinium uliginosum*, *Solidago alpestris*, and *Oxycoccus oxycoccus* (J. Bequaert Coll.). Probably this color variant deserves to be named, but before doing so we shall await the discovery of the queen.

Bremus affinis var. **novae angliae** (J. Bequaert).

This color variant was described from Forest Hills and Sherborn, Massachusetts, and Brooklyn, New York (J. Bequaert, 1920, p. 6–8). Frison (1923, p. 324) has since recorded two males, from Virginia and North Carolina. We have also seen one male from N. Egremont, Massachusetts, September 18, 1922, and three males from Colebrook, Connecticut, September, 1918, August, 1919, and August, 1922 (W. M. Wheeler Coll.) in which the fourth tergite is mostly covered with rufous pile.

At Forest Hills the var. *novae angliae* is frequently seen, but it should be noted that *Bremus affinis* is one of the more common bumblebees of that locality. As we have now before us thirty-one males, twenty-two workers, and four queens, it is possible to describe this color variant more fully.

Queen (undescribed). Differs from the typical *affinis* queen in having the black pile of the fourth abdominal tergite almost entirely or to a large extent replaced by vinaceous rufous hairs. The pile of the second tergite is pure yellow as usual in the queen of *affinis*.

In the allotype and two paratypes the rufous pile covers nearly the whole width of the tergite, forming a conspicuous fascia between the black third and fifth tergites. In another paratype the sides of the fourth tergite are covered with black pile only.

These four queens of *novae angliae* were part of a lot of twenty young queens found in a nest of *affinis*, at Forest Hills, August 14, 1924. Two other queens showed a faint sprinkling of rufous hairs on the fourth tergite, while the remainder were without a trace of rufous pile, *i.e.* typical *affinis*. The nest also contained seven workers of the usual *affinis* pattern; the old queen was no longer present. On April 23, 1925, the junior author also observed a queen of *novae angliae* on willow in the Arnold Arboretum, at Forest Hills.

Worker.— In the majority of the specimens the rufous pile is, as in the queen, restricted to the fourth tergite, which it often covers almost entirely; in some specimens there is an admixture of black hairs in the basal half or on the sides. Rarely the fifth tergite also is partly rufous

and such specimens generally show an admixture of rufous pile along the hind margin of the third tergite. We have not yet seen workers which are as extensively rufous as some of the males.

Male.— The most common type is similar to that usually found in the queen and worker; the fourth tergite alone is almost entirely covered with rufous pile. Sometimes there is an even admixture of black hairs; more often the rufous pile forms a median, somewhat triangular patch. When the rufous is more extended, it invades the fifth tergite, more rarely the sixth also. We have seen no examples in which the seventh tergite is not covered with black pile. The third tergite also is almost always pure black; in but one specimen is there an abundant sprinkling of rufous hairs.

The junior author has recorded (Plath, 1922, p. 191) finding two nests of *B. affinis* containing workers of the typical form as well as of the var. *novae angliae*. Similar observations were made during the summer of 1923. One nest, taken July 7, contained the old queen (normal *affinis*), fifty-seven workers of typical *affinis* and twelve workers of var. *novae angliae*. A second nest (July 25) contained the old queen (normal *affinis*) and forty workers, several of which were of the var. *novae angliae*. A third nest (July 28) contained a normal old queen and forty-five workers, several of the var. *novae angliae*. A fourth nest (July 29) was queenless; the twenty workers were all normal *affinis*, but a number of the ten males were of the var. *novae angliae*.

As mentioned above, the description of the queen of var. *novae angliae* is based upon four specimens obtained with sixteen others from a single nest (August 14, 1924). One of these queens showing no trace of rufous pile on the abdomen, represents an extreme melanistic variation, which, we believe, has not yet been recorded. In this specimen the second tergite of the abdomen is almost wholly covered with black pile; along the basal margin only there is a narrow strip of yellow hairs.

Twenty-one nests of *B. affinis* were examined by the junior author at Forest Hills during the summers of 1921 to 1924 and seven of these contained specimens of the var. *novae angliae*. But not a single pure colony of that variety was ever observed.

In normally colored *B. affinis*, the differences between the queen and the worker are more marked than usual among bumblebees, so much so that Franklin was at first in doubt that they were conspecific. In the worker, as well as in the male, the dorsum of the thorax usually shows a strong admixture of black pile with the yellow, forming an indefinite or a rather distinct black interalar band; in addition, the

second abdominal tergite is extensively covered with brown ferruginous pile. In the queen, the dorsum of the thorax is almost wholly yellow, there being but a slight admixture of black hairs near the bare area of the disk; the second abdominal tergite is entirely clothed with pure yellow pile. Occasionally, however, one finds queens that present one or the other, or both these characteristics of the worker. We have before us two queens, collected this spring (1925) at Forest Hills, with a fairly distinct interalar black band and one of these also shows a faint indication of brownish pile near the base of the second tergite. Moreover, during 1924, the junior author observed in the same locality a number of queens which were colored like the worker.

Suggestions as to the Significance of Color Variation in Bumblebees.

Many species of the Bremidae are unusually variable in color and, since they are of large size and rather readily collected in extensive series, they have become great favorites with certain students of variation in Europe. The literature of this subject is already quite extensive and we do not intend to review it at present. As this aspect of the study of bumblebees has been rather neglected in this country, we wish, however, to present briefly some considerations suggested by a study of the local species.

A multitude of names has been proposed in recent years for the several color variants of Palaearctic Bremidae. Perhaps somewhat too rashly; for some European students do not appear to have heeded the rather wide range of fluctuating variation within the limits of the same color form. On the other hand, to merely regard all color variations of the species as unimportant "variants" of equal value, does not, in our opinion, do justice to the facts; neither does it stimulate further research. It is mainly for this reason that we have proposed varietal names for a number of color variants, not mentioned by Franklin, which seem to fall beyond the range of individual variation. It is important that the geographical distribution as well as the genetic relationship of such variants be properly studied. We feel, however, no inclination to pilfer other people's work, and we have therefore refrained from naming any of the "color variants" described by Franklin, although some of them should eventually receive recognition in nomenclature.

Franklin's main objection to giving his "color variants" of bumble-

bees any particular rank in nomenclature, is that "different gradations are often found together in the same nest." His conclusion, however, that in such cases the gradations are the offspring of the same queen, is not always warranted. It is by no means exceptional to find workers of two distinct species living in perfect harmony within the same nest. The junior author has recorded finding two nests of *Bremus affinis*, each containing a worker of *B. terricola* (Plath, 1922, p. 191), and in 1923 he observed two other similar cases. He has also shown (1923) that certain species of bumblebees rather readily adopt foreign workers or queens of the same or of different species, producing mixed colonies. In other cases, however, members of two closely related species may refuse to have anything to do with each other, even after they have been together for weeks, and although the members of one of these species have been reared by the other (Plath, 1924, p. 73). Moreover, queens which have started colonies are often killed by others of the same species which enter their nests, so that the members of one colony are not necessarily the offspring of one queen (Plath, 1924, p. 74). Incidentally it may be noted that such observations greatly impair the theoretical significance of Friese and F. v. Wagner's (1904, p. 563) distinction between "homonidal" and "heteronidal" color variants in bumblebees.

Color variation in insects is undoubtedly due to a variety of causes. Upon purely theoretical grounds, however, the various possibilities may be brought together into the following four groups: —

(1) *Individual differences due to fluctuating or continuous variation.* If a large number of individuals of a species be examined, all characters exhibit a certain amount of variation, although extreme aberrations from the average or majority are generally scarce. In certain characters the variation may be inconspicuous, while in others it is very pronounced. In bumblebees, the color of the pile is undoubtedly much less constant than the structural characters, and Franklin is quite right in relying mainly upon the latter in the determination of the species. Individual variants should not, we believe, be given a standing in nomenclature, although it is not always easy to recognize them as such.

(2) *Sports or mutations.* Discontinuous variation, in which a new character or group of characters suddenly appears and is inherited in its new form, has been observed in several groups of insects. Quite likely it is found in bumblebees as well, where its occurrence will, however, be rather difficult to prove experimentally. Mutations are of especial interest, since many naturalists believe that they are due to a modification of the germ plasm and consequently represent

incipient species. The relations between color variations of bumblebees and mutations have been discussed by Vogt (1911, p. 38–42).

(3) *Hybridism.* Upon finding forms that apparently connect two closely allied species, one is readily inclined to regard them as the result of crossing. Yet this explanation should be used with extreme caution, unless it is confirmed by experimental work. Franklin (1912, p. 237) remarks with regard to the Bremidae: "On account of the difficulties met in arranging the species, some have been led to think that hybrids are common. The writer has never yet seen a single specimen of this family which, in his opinion, was a hybrid." Franklin's extensive experience with North American bumblebees certainly permits him to speak with authority. W. Wagner (1906, p. 3–4), however, believes that hybridism is responsible for much of the polymorphism in bumblebees.

In a former paper the junior author suggested that *Bremus affinis* var. *novae angliae* might be a hybrid between *B. affinis* and *B. terricola* (Plath, 1922, p. 191), but he no longer adheres to that view.

It is quite possible that hybridism may account for some at least of the intergrades which connect what appear to be distinct color entities of the same species. It may, for instance, explain the occasional occurrence of individuals seemingly intermediate between *Psithyrus laboriosus* and its var. *citrinus*. If Mendelian segregation prevails among bumblebees, crossing might also elucidate the occurrence of two different color types in certain nests, as in the case of the mixed colonies of *Bremus affinis* and its var. *novae angliae*. Here again the chief difficulty will be to acquire absolute certainty that all the inmates of a given colony are the offspring of the same queen.

(4) *Somatic variation under the influence of the environment (climatic factors, food, parasites, etc.).* The far-reaching effect of changes in the environment upon the external characters of animals and plants is now generally recognized. In bumblebees it is, for instance, suggested by their climatic variation. Franklin (1912, p. 200–202) has some interesting remarks upon this subject. He points out that species of Bremus with a comparatively level habitat of wide extent are not usually very variable, whereas greatly variable species are only found in greatly diversified regions. "No North American species which has the greater part of its range east of the Pacific Highland is very variable, while several of those, the habitats of which are in Alaska, western Canada and the Pacific States of the United States, show astonishing variation in the coloration of their pile. * * * In South America, the most variable species have the greater part of their habitat in the highland of the Andes."

Franklin's remarks upon the geographic distribution of the several color types in Bremus so directly bear upon our discussion of rufous variants in certain New England species, that we quote them in full: "In the coloration of the pile, those colors which may, in general, be classed as ferruginous, rufous and white are, as a rule, brought out by high altitudes and also by Arctic or sub-Arctic latitudes, only traces, at most, as a rule of these colors being found on strictly lowland forms either in tropical or temperate climates. High altitudes appear to have a much stronger influence in bringing out these colors than do high latitudes, as among the New World species, these colors attain their maximum among the Cordilleras of the Andes in Ecuador and Peru where bumble-bees reach the highest elevations. Traces of ferruginous or rufous pile on lowland temperate or tropical species (*e.g.* — *affinis*, second dorsal segment of worker and male abdomen; *fraternus*, apex of male abdomen; *separatus*, second dorsal abdominal segment of all sexes) may, perhaps, be taken to indicate a mountain inhabiting ancestry." * * * "Yellow is more or less strongly suppressed in the coloration of the pile of tropical species of the genus *Bombus*. This suppression is marked in both lowland and highland forms, and is so strong that this color is entirely wanting in a large percentage of the species in the tropics of the New World. In the lowlands this has resulted in some cases in the production of entirely black species (*kohli, niger, atratus, brevivillus, solus*). In the mountain regions black is less prevalent, for the rufous or the white pile on the mountain forms replaces the suppressed yellow more or less."

An instructive example of modification of color of the pile in bumblebees through changes in external conditions, has been reported by Hoffer (1905). On August 10, 1890, a large nest of *Bremus agrorum* was found on sandy soil in the shade of a house; it contained 150 bumblebees, among them the old queen and two males, also many pupae, but no adult young queens. It was placed in a flower-pot on a substratum of loose earth and kept on a window-sill facing the south. As the sun was particularly hot on that window, Hoffer almost every day poured water in the flower-pot. The first individuals which hatched in captivity showed the normal coloration, with much black on thorax and abdomen. Most of those that developed after August 19, were magnificent examples of the yellow variety known as *floralis;* so that when later the older inmates had either died or left the nest, the colony consisted of the var. *floralis* only. Hoffer concludes that the high diurnal temperature, combined with light and humidity, produced the yellow coloration. He also states that, in later yea

he changed the pale var. *floralis* into typical *agrorum* and even into the dark varieties *mniorum* and *tricuspis*, by removing the sunlight and lowering the temperature.

The foregoing considerations may throw some light upon the occasional occurrence of rufous color variants in some of the North American species of Bremus. We know at present four species of bumblebees, viz. *Bremus separatus*, *B. bimaculatus*, *B. vagans*, and *B. affinis*, which in the vicinity of Boston show a marked tendency to produce a rufous modification of the black pile. We have evidently to do with a case of convergence or parallel variation, of which many beautiful illustrations are found among the Bremidae. In certain regions, such as the island of Corsica and the Caucasus Mountains, there is an unusually strong tendency to produce homomorphism in bumblebees. (see Friese and F. v. Wagner, 1904, p. 564 and 568, and 1910, p. 74–79. Vogt, 1909, p. 47–54, and 1911, p. 65–69).

The four species of New England bumblebees under discussion are not genetically related; in fact they belong to three quite distinct morphological groups within the genus Bremus. It is not likely therefore that their rufous color variants are due to some common modification of the germ plasm, merely inherited through crossing. We are inclined to explain their appearance in the same locality through the action of certain environmental factors upon the development of pigment in the pile. In this connection it may be mentioned that Friese and Wagner (1910, p. 16–17 and p. 71–73) regard rufous as an intermediate coloration in the ontogenetic development of the black vestiture among bumblebees. When the young bumblebee freshly hatches from the pupa it is uniformly covered with whitish or grayish white pile; they claim that this first turns reddish yellow, later red, and finally black, reddish or rufous being a necessary step in the production of black pile. On the other hand, the yellow color, they state, develops quite independently from the original grayish white pile and does not belong in the development series white-red-black.

It is noteworthy that in *B. affinis* var. *novae angliae* and the other rufous color variants under discussion, the rufous coloration merely replaces the black, so that, if Friese and Wagner are correct, there might be some justification in regarding them as cases of arrested development. Yet the case is not quite so simple, for a study of a large number of individuals in the var. *novae angliae* shows that the rufous modification begins on the fourth tergite, at first as a mixture of rufous pile among the usual black hairs; it eventually spreads over the whole of this tergite, in some individuals invades the fifth, and

even occasionally the sixth tergite; but the third tergite either remains entirely black or shows only a slight admixture of rufous hairs along the hind margin.

Although we regard these rufous color variants as most likely due to the operation of external influences, it is nevertheless difficult to imagine how they might be adaptive or advantageous modifications. It is still more difficult to conceive how they might become the starting point of a selective process. Vogt (1909, p. 55–58) has alluded to some of the difficulties that beset any attempt at explaining color variation in bumblebees on the basis of the theory of natural selection.

The Bumblebee Fauna of Connecticut

For several years Prof. W. M. Wheeler has made a rather close study of the bumblebee fauna near his summer home at Colebrook, Connecticut. It seems worth while to list the species which he has observed in that locality.

1. *Bremus terricola* (Kirby). Common.
2. " *affinis* (Cresson). Common.
3. " " var. *novae angliae* (J. Bequaert). Rare.
4. " *borealis* (Kirby). Very rare.
5. " *bimaculatus* (Cresson). Common.
6. " *impatiens* (Cresson). Common.
7. " *ternarius* (Say). Fairly common.
8. " *perplexus* (Cresson). Common.
9. " *vagans* (Smith). Common.
10. " *fervidus* (Fabricius). Moderately common.
11. " *americanorum* (Fabricius) (= *pennsylvanicus auct.*). Not common.
12. " *separatus* (Cresson). Moderately common.
13. *Psithyrus laboriosus* (Fabricius). Common.
14. " " var. *citrinus* (Smith). Common.
15. " *ashtoni* (Cresson). Common.
16. " *fernaldae* Franklin (=*tricolor* Franklin). Not rare.

The most interesting of these species is *B. borealis*, of which a single queen was obtained July 22, 1921. This is the first record for Connecticut and the southernmost locality known for the species. Viereck (1916, p. 759) also has one Connecticut record of *B. auricomus* (Robertson), a rather southern species, probably restricted to the coastal area of the state. Possibly *Bremus fraternus* (Smith) and *Psithyrus variabilis* (Cresson) may yet be discovered there. Viereck still lists *B.*

vagans var. *consimilis* Cresson as a form distinct from *B. vagans,* although Franklin has shown their identity. Upon referring to the original description of *consimilis* (Cresson, 1864, p. 41), one finds that it is "colored same as *vagans* Smith, but is much smaller and more robust in proportion to the size." According to Viereck's key (1916, p. 755) the vertex bears black pubescence only in the queen and worker of typical *vagans,* whereas it has yellow hairs in the var. *consimilis.* The color of the pile of the vertex is somewhat variable in this species; but we have not yet seen specimens in which it is entirely black. We are unable to separate our material of *vagans* into two races based upon the color of the pile of the vertex.

One species should be added to the list of the bumblebees of the vicinity of Boston previously published (J. Bequaert, 1920). The junior author has recorded a number of captures of *Bremus borealis* at Forest Hills (Plath, 1922*b*, p. 193–194 and 1923, p. 331–332), where Prof. W. M. Wheeler has also taken a queen July 31, 1911. We may note that *B. ternarius* has been taken during several successive years at Forest Hills.

The rarest of New England bumblebees appears to be *Bremus rufocinctus* (Cresson), which was of especial interest to us, because it rather frequently exhibits rufous variations somewhat similar to those described in the present paper for other species of Bremus. So far as we know there is only one definite record from New England in the literature. It concerns the nest taken by Putnam, about 1863, at Bridport, Vermont, specimens of which were recognized by Franklin (1912, p. 444) as belonging to *rufocinctus.* We have now before us one worker taken at Chittenden, Vermont, August, 1916 (J. Bequaert Coll.), which agrees quite well with the description of *rufocinctus.*

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NOV 18 1925

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LXVII. No. 7.

NEW GENERA OF MEGAPODAGRIONINAE, WITH NOTES ON THE SUBFAMILY.

By Clarence Hamilton Kennedy.

With One Plate.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
November, 1925.

No. 7.— *New genera of Megapodagrioninae, with notes on the subfamily.*

By Clarence Hamilton Kennedy.

INTRODUCTION.

While studying the Zygoptera of the Hagen Collection in the Museum of Comparative Zoölogy, in 1917, I noticed two males and two females of an undescribed Megapodagrionine dragonfly, which were labeled "West Australia," "Hagen." They were exceedingly interesting in that they were the smallest species of the Megapodagrioninae yet found, being of the size of the smaller Ischnuras. Further study shows that they are very generalized in both body and wing characters.

I wish to thank Mr. R. J. Tillyard of the Cawthron Institute, Nelson, New Zealand, for specimens of *Argiolestes minimus* Tillyard and *Argiolestes pusillus* Tillyard and the authorities of the Museum of Comparative Zoölogy for the privilege of describing the specimens in their charge.

DESCRIPTIONS OF GENERA AND SPECIES.

Archiargiolestes, gen. nov.

Type.— *Archiargiolestes pusillissimus* Kennedy.

Megapodagrionine in that there are two antenodals, Rs and M_3 arise near the subnodus and there are various extra sectors between M_{1a} and Cu_1.

Wings with 10–12 postnodals, stigma short, surmounting two cells, an oblique stigmatic brace vein. Rs arises at the subnodus, M_3 arises before the subnodus, M_2 arises at postnodal 3 or 4, M_{1a} arises 3–4 costal cells before the stigma. Ac is at a level about midway between the two antenodals. The quadrangle has the anterior side 1–2 times as long as the outer side, the outer posterior angle acute. There are two postquadrangular cells and the area posterior to Cu_2 has a single row of 10–11 cells. Wing petioled to the middle level of the quadrangle.

In addition to the type species the genus includes *Argiolestes pusillus* Tillyard and *A. griseus* Selys; all confined to western Australia.

Archiargiolestes pusillissimus, sp. nov.

Plate, fig. 2.

Type.— M. C. Z. 15,356. ♂. West Australia. Thorey (Hagen Coll.). Paratype.— M. C. Z. 15,357. ♀. West Australia. Thorey (Hagen Coll.).

Holotype = male in Museum of Comparative Zoölogy which bears the labels "West Australia Thorey," "Hagen" and "penis drawn." Paratype = female with the holotype, labeled "West Australia Thorey" and "Hagen." Two other specimens accompany these, having similar labels, one, a male is undoubtably conspecific but the other, a female, is so much more robust than the paratype that there is a remote possibility that she may belong to another species.

Colors largely black and creamy white. The striking feature of the coloration is the sharpness of the edges of the black areas on the head and thorax. There is no shading of black into creamy.

Head with base of mandibles brown, labrum creamy, broadly edged below with black. Clypeus creamy on its vertical surface, black on its horizontal surface. Genae creamy. The entire dorsal surface of the head black.

Prothorax with a large posterior lobe, the edge of which is divided into three hardly noticeable, subequal portions by two shallow notches. Entire dorsal and lateral surfaces black.

Meso- and metathorax with the dorsal surface black and the sides black except the following:— the lower one fourth of the mesinfraepisternum, the metaepisternum from the middle coxa to the spiracle and the mesepimeron. Coxae creamy. Legs pale brown with an outer and a dorsal row of minute spots on the femur; spines dark brown. Wings hyaline, stigma brown. Thorax sparingly covered with long coarse white pile.

Abdomen dark brown (black in the second male and the two females) with creamy on the under side and a narrow creamy basal ring around segments 3–8. Appendages brown. Dorsum of segments 1 and 2 pruinose.

Length:— abdomen (including appendages) 19 mm., hind wing 14 mm.

Superior appendages forcipate and notched at the apex, the inferiors rudimentary.

Archiargiolestes pusillus (Tillyard).

Plate, fig. 1.

Argiolestes pusillus Tillyard, Proc. Linn. soc. N. S. W., 1908, **32**, p. 736.

This was described as a variety of *Argiolestes minimus* Tillyard and as similar to *minimus* but smaller. No sufficient figure of wings or

appendages was published. Later Tillyard published figures of *minimus* (Proc. Linn. soc. N. S. W., 1913, **37**, pl. 45, fig. 3, 4). My figures of M. C. Z. specimens did not agree with these in certain details, and on comparison with specimens of both *minimus* and *pusillus* received from Mr. Tillyard were so different in the male appendages that I separate the M. C. Z. specimens as a new species, *pusillissimus*, consider *pusillus* distinct from *minimus*, and describe the new genus Archiargiolestes for *pusillus* and *pusillissimus*, while *minimus* remains in Argiolestes because of the double row of cells in the Cu_2 area.

Mr. Tillyard states (Proc. Linn. soc. N. S. W., 1908, **32**, p. 737) that *minimus* and *pusillus* occur with intergrades connecting them at "Bridgetown, Wilgarrup and probably other localities." It is probable that the intergrades are a third undescribed species, unless, of course, they are of unusual sizes. Mr. Williamson's recent work (Occ. papers Mus. zool. Univ. Mich., 1919, no. 68) on South American Megapodagrionines, as well as that of Ris (Archiv naturg., 1916, **82**), shows that there are many close but distinct species in this subfamily.

In trying to place these generically, the described species of Argiolestes and related genera have been studied as carefully as could be from the literature and the few species represented in American collections, and a tentative revision of the subfamily has been made. The following new genera are described for certain unusual species.

Caledargiolestes, gen. nov.

Plate, fig. 3.

Type.— *Argiolestes uniseries* Ris, Nova Caledonia (Sarasin & Roux), Zool., 1915, **2**, l. 1, p. 62, fig. 5, 6.

Megapodagrionine in general characters. Characterized by the following combination of characters:— Ac near the level of antenodal one; 14 postnodals; stigma short, surmounting two cells and having an oblique brace vein. M_3 arising the length of a small cell before the subnodus, Rs arising at the subnodus, M_2 beyond the fifth postnodal. M_{1a} arises two cells beyond the origin of M_2 or 6–7 cells before the stigma. Cu_2 16–19 cells long with a single row of cells back of it. Petiolation to the level of the middle of the quadrangle which has its anterior side 2–3 times as long as the outer side so that the outer posterior angle is acute. Two postquadrangular cells. Extra sectors as follows:— M_{1a}–M_2 1–2; M_2–Rs 2; Rs–M_3 2; M_3–M_4 2–3; M_4–Cu_1 1.

Male inferior appendages nearly as long as the forcipate superiors.

Length:— abdomen 30 mm., hind wing 25 mm.

Austroargiolestes, gen. nov.

Plate, fig. 4.

Type.— *Argiolestes icteromelas* Selys, Bull. Acad. roy. Belgique, 1862, p. 376. Melbourne, Australia.

This genus includes also *aureus* Tillyard,[1] *chrysoides* Tillyard,[2] *minimus* Tillyard,[3] *amabilis* Forster[4] and *alpinus* Tillyard.[5] Probably several of Tillyard's "varieties"[6] are good species when more material becomes obtainable for study.

Venation Megapodagrionine. Ac at the level of antenodal two. Rs arising at the subnodus, M_3 before the subnodus; 15–23 postnodals; stigma oblique, surmounting 1½–3 cells. Wing petioled to the base or the middle of the quadrangle, three postquadrangular cells. Cu_2 area with two rows of cells in its outer part. Extra sectors as follows: M_{1a}–M_2 2; M_2–Rs 2; Rs–M_3 2; M_3–M_4 5–6; M_4–Cu_1 2.

Male superiors forcipate and toothed while the inferiors are rudimentary.

Length:— abdomen 26–34 mm., hind wing 20–30 mm.

This genus is more primitive than any of the Argiolestine genera of the Papuan region, except Podolestes and Caledolestes, in the position of Ac under antenodal two and in the Cu_2 area with its single extra row of cells.

Argiolestes Selys.

Bull. Acad. roy. Belgique, 1862, p. 372.

Type.— *Agrion australis* Guérin, Voyage Coquille. Zool., 1831, **2**, pt. 2, p. 196. Offak.

I include also *pallidistyla* Selys,[7] *selysi* Forster,[8] *rouxi* Ris,[9] and *macrostylis* Ris,[10] though, in the origin of M_3 and Rs, the last species appears to lie between Argiolestes and Wahnesia. Until the Selysian material is restudied the exact boundaries of this genus cannot be finally determined.

[1] Proc. Linn. soc. N. S. W., 1906, **31**, p. 178, pl. 17, fig. 1. 1913, **37**, p. 415, pl. 45, fig. 1, 2.
[2] Proc. Linn. soc. N. S. W., 1913, **38**, p. 237, pl. 15, fig. 8, 9.
[3] Proc. Linn. soc. N. S. W., 1908, **32**, p. 735, pl. 35, fig. 11, 12.
[4] Ann. Soc. ent. Belgique, 1899, **43**, p. 71.
[5] Proc. Linn. soc. N. S. W., 1913, **37**, p. 417, pl. 44, fig. 7, 8.
[6] *Argiolestes icteromelas* race *nobilis* Tillyard, Proc. Linn. soc. N. S. W., 1913, **37**, p. 410.
[7] Mitth. Zool. mus. Dresden, 1878, **3**, p. 320.
[8] Ann. Soc. ent. Belgique, 1899, **43**, p. 70.
[9] Nova Caledonia (Sarasin & Roux), Zool., 1915, **2**, l. 1, p. 60, fig. 3, 4.
[10] New Guinea (Lorentz), Zool., 1913, **9**, l. 3, p. 475.

Argiolestes is thus restricted to that group of the Selysian Argiolestes in which M_3 arises shortly before the subnodus and Rs at or close to the subnodus. This is Selys's group C after the removal of *cincta* to Celebargiolestes.

Rs arising at the subnodus, M_3 arising shortly before the subnodus; postnodals 20–25;[1] quadrangle of moderate length, *i.e.*, there are 2–4 postquadrangular cells; Ac lies under antenodal one; the Cu_2 area has short sectors 2–4 cells long.

Male inferior appendages rudimentary ?

Length:— abdomen 28–43 mm., hind wing 25–29 mm.

Argiolestes rouxi Ris, isolated in New Caledonia, is probably also generically distinct from the other species.

Caledopteryx, gen. nov.

Type.— *Argiolestes sarasini* Ris, Nova Caledonia (Sarasin & Roux), Zool., 1915, **2**, l. 1, p. 58, fig. 1, 2.

Ac lies near the level of antenodal one; petiolation only to the base of the quadrangle; M_3 arises shortly before the subnodus and Rs at the subnodus; apex of quadrangle not reaching the level of the middle of the third antenodal space; 4 postquadrangular cells; about 30 postnodals; stigma oblique, surmounting 2–3 cells and with an oblique brace vein; M_2 arising near postnodal 11–12, M_{1a} arising 4 cells farther out; apex of Cu_2 reaching level of postnodal 18–20 with many short branches, many of which are 3–4 cells long; extra sectors as follows, M_{1a}–M_2 2, M_2–Rs 2, Rs–M_3 2, M_3–M_4 6, M_4–Cu_1 2.

Male inferiors long.

Length:— abdomen 43–48 mm., hind wing 39–40 mm.

This genus is close to Argiolestes, but differs in having 30 postnodals, 4 postquadrangular cells and in the well-developed branches on Cu_2. It differs from Podopteryx in having Ac under antenodal one, in the narrower stigma and in the shorter branches on Cu_2. From Celebargiolestes it differs in having fewer postnodals.

Celebargiolestes, gen. nov.

Plate, fig. 5.

Type.— *Argiolestes cincta* Selys, Mem. Acad. roy. Belgique, 1886, **38**, p. 86.

The following description is from a male collected in the Tokalla

[1] *Argiolestes selysi* Forster has 29–35 postnodals and because of its greater size, abd. 54 mm., may be generically distinct.

Mountains, Celebes Island by I. Rolle in 1915 and presented to Mr. Williamson by Dr. Ris whose label *Argiolestes cincta* ♂ is still on the pin.

Ac under antenodal one; wing petioled to middle of quadrangle; origin of M_2 and Rs normal; 35–40 postnodals, several double cells beyond stigma; M_2 arising at postnodal 13–15, M_{1a} at 15–19; stigma normal, surmounting 3–4 cells, no brace; postquadrangular cells 4; extra sectors, M_{1a}–M_2 4–, M_2–Rs 2, Rs–M_3 2, M_3–M_4 4–, M_4–Cu_1 2; Cu_2 about 28 cells long with 8 or 9 branches 2–5 cells long. Male inferiors one half as long as the superiors.

Length:— abdomen 34–36 mm., hind wing 30–32 mm.

The great number of postnodals at once separates this genus from all other genera of the Argiolestes series. It is a moderate-sized species so its wings are more densely veined than are those of Podopteryx and Caledopteryx, both of which have fewer postnodals.

Burmargiolestes, gen. nov.

Plate, fig. 6.

Type.— *Argiolestes melanothorax* Selys, Ann. Mus. civ. Genova, 1891, ser. 2, **10**, p. 500.

Megapodagrionine with the following distinctive combination of characters: M_3 arises at the subnodus, Rs at the first postnodal, M_2 at postnodal 8–9, M_{1a} near postnodal 11–12. Ac lies under antenodal one. Petiolation to the middle level of the quadrangle. Quadrangle six times as long as wide, its apex reaching the level of the nodus so that the subnodus lies over the first of the one or two postquadrangular cells. About 24 postnodals (17–23 Selys); stigma surmounting one and one half cells and having an oblique brace vein. Cu_2 14–16 cells long with 5–14 cells of a second row which commences 4–5 cells distad of the quadrangle.

Length:— abdomen 30–38 mm., hind wing 25–27 mm. Male inferiors rudimentary.

This differs from Wahnesia, which also has M_3 arising at the subnodus, in that the quadrangle reaches to the level of the nodus. This character may relate it to Allolestes of the Seychelles, which also has a long quadrangle. It distinguishes it at once from all of the Papuan genera of the Argiolestes series.

Two new mainland species have been discovered recently.

Oligoargiolestes, gen. nov.

Type.— *Oligoargiolestes oligocenum* Kennedy.

I suggest *oligocenum* for the second fragment identified by Cockerell

and Andrews (Proc. Biol. soc. Washington, 1916, **29**, p. 90, pl. 2, fig. 5) as *Megalestes anglicus*. It is from the Oligocene of the Isle of Wight and is too fragmentary to describe definitely. The tip is too rounded to be a Lestid, therefore the short stigma and extra sectors show that it is a Megapodagrionine. The strong stigmatic brace vein suggests relationship to the Argiolestine series of genera.

Miopodagrion, gen. nov.

Type.— *Lithagrion optimum* Cockerell, Proc. U. S. N. M., 1916, **51**, p. 101.

These fragments may not be even Megapodagrionine, but they are not Lithagrion as the petiolation is much less than in that genus. The fragment with double cells in the Cu_2 area suggests Argiolestes.

NOTES ON SOME GENERA.

Archiargiolestes Kennedy, 1925. Western Australia. Three species.

Length:— abdomen 19–21 mm., hind wing 14–16 mm. Male inferiors rudimentary.

This is one of the very primitive and generalized genera of the Megapodagrioninae. The characters that indicate this are the simple Cu_2 area, the position of Ac basad of antenodal two, the normal origin of M_3 and Rs, the few sectors, and the simple stigma. Its primitiveness is further indicated by the small number of species and that it occurs in Western Australia, one of the oldest and most isolated regions, zoögeographically. *Archiargiolestes pusillissimus* with an abdomen only 19 mm. long is the smallest known Megapodagrionine. It is an interesting light on the size of the primitive ancestral Zygopter that all the large Megapodagrionines are very specialized while the primitive and generalized Megapodagrionines are small. The very primitive and generalized Hemiphlebia is also a small insect.

This genus is specialized in the considerable petiolation, the short Cu_1 and Cu_2, in the two postquadrangular cells and in the rudimentary inferior appendages of the male.

Archiargiolestes griseus Selys, and probably also *fontanus* Tillyard, the latter as yet unstudied, are included in this genus. This *griseus* is the species identified by Tillyard as *griseus* Selys. In Williamson's collection is another species labeled *griseus* Selys by Martin, but which

by the specialized penis, the spined male superiors, and the venation though the Cu_2 area is a single row of cells is an Austroargiolestes. This latter is an undescribed species, if Martin is mistaken. The *griseus* of Tillyard (and Selys?) belongs in Archiargiolestes by the generalized penis, the spineless male superiors, and the venation.

The species *minimus* has the venation of Austroargiolestes, but the male appendages are spineless and resemble those of the species of Archiargiolestes. The penis is also more generalized than is usually found in Austroargiolestes in that the apical lobes are unmodified as in Archiargiolestes. Thus *minimus* is intermediate between the two genera, if all characters are considered, but based on venation it is distinctly a species of Austroargiolestes.

Caledargiolestes Kennedy, 1925. New Caledonia. One species, *C. uniseries* (Ris) from New Caledonia, 900 miles east of Australia, one of the most isolated zoögeographic regions.

Length:— abdomen 30 mm., hind wing 25 mm. Male inferiors long.

Venationally this is close to Podolestes, Trineuragrion, and Archiargiolestes. It differs from all three in having Ac more nearly under antenodal one than under antenodal two. If this evidence is of value, it is intermediate between the Australian genera and the Papuan Argiolestes. On the other hand it is so similar to Trineuragrion in the simple Cu_2 area and the long inferior appendages of the male that the latter may have been derived from Caledargiolestes.

Lithagrion Scudder, 1882. Miocene. Florissant, Colorado. One species.

Probable length of wing 33 mm.

Lithagrion umbratum and *optimum* have already been removed from this genus. Scudder's type had no distinct stigmatic brace vein. However Cockerell had what he thought was a second fossil of this species, which agreed with *hyalinum* otherwise but had a stigmatic brace. (*Cf.* Bull. Amer. mus. nat. hist., 1907, **23**, p. 137, 1908, **24**, p. 63). A stigmatic brace would make the fossil agree with the other Florissant Odonata, which are related to the Oriental genera rather than with the South American Megapodagrionines. If it has three antenodals as Cockerell's specimen appeared to have, it is close to Trineuragrion of New Caledonia which it resembles also in the position of Ac and in the irregular group of cells between the tips of M_3 and M_4. It is evidently more primitive than the present-day Argiolestes (*australis*), Wahnesia, Podopteryx, and relatives with an enriched Cu_2 area.

Lithagrion is not closely related to Thaumatoneura and Para-

phlebia of modern Mexico and Central America. These differ in the short Cu_2 with numerous Cu_1–Cu_2 sectors attached to its tip. Lithagrion, Melanagrion, and Miopodagrion appear to represent a stock entering from the Orient but which appears to be somewhat distinct from the Paraphlebia-Thaumatoneura stock. The latter may be an earlier stock yet, as their penes are so generalized that they might fit species in the Megapodagrioninae, Agrioninae, or Coenagrioninae.

Melanagrion Cockerell, 1907. Miocene. Florissant, Colorado. One species.

Length of wing 34.5 mm.

This genus, based on *Lithagrion umbratum* Scudder, is close to Austroargiolestes as it has Ac under antenodal two, a conspicuous stigmatic brace vein, and a Cu_2 area with several double cells. This relates it to the more primitive Megapodagrionines of the Indo-Australian region rather than with the more specialized genera of the Papuan region. This suggests that the Old World genera with the rich Cu_2 areas may have developed since the Miocene.

Eopodagrion Cockerell, 1920. Eocene. Green River, Wyoming. Two species. Based on fragments of two wings, *Podagrion abortivum* Scudder and *Eopodagrion scudderi* Cockerell, suggested by Cockerell to have been perhaps the front and hind wing of the same species.

These are probably Megapodagrionine, if so they belong to the Old World series because of the distinct stigmatic brace vein. The simple Cu_2 area places this genus among the primitive genera. These fossils give us an Eocene horizon for the primitive Megapodagrionines though they probably arose before this.

Oligoargiolestes Kennedy, 1925. Oligocene. Isle of Wight, England. New name based on the second fragment of *Megalestes anglicus* Cockerell.

The shape of the wing apex is Megapodagrionine and not Megalestine. Because of its stigma with an oblique brace vein it falls among the relatives of Argiolestes, though it has the regular splitting of the marginal cells found in Neurolestes of the Cameroons.

Miopodagrion Kennedy, 1925. Miocene. Florissant, Colorado. New name for *Lithagrion optimum* Cockerell.

This is so fragmentary that it may or may not belong here. Cockerell places it next *Lithagrion hyalinum* but, if his figure is correct, it is not petioled beyond Ac, which makes it necessary to give it a distinct generic name.

Austroargiolestes Kennedy, 1925, Australia. Several species.

Length:— abdomen 24–36 mm., hind wing 20–33 mm. Superior

appendages of the male with a large inferior subapical tooth, inferiors rudimentary.

This genus was erected to include *Argiolestes icteromelas* Selys and those other Australian species in which Ac lies nearer antenodal two, petiolation ceases near the base of the quadrangle; the male superior appendages have a large inferior subapical tooth and there are usually 2–3 rows of cells in the Cu_2 area. The penis usually has narrow lobes that are more or less united into a narrow tip. Besides *icteromelas*, it includes *amabilis* Forster, *alpinus* Tillyard, *chrysoides* Tillyard, *aureus* Tillyard, and *minimus* Tillyard. An unnamed species of Austroargiolestes, male and female, occur in Mr. Williamson's collection which were labeled by Martin *griseus* though they are close to the species identified by Tillyard as *icteromelas* Selys. They have a large subapical spine on the superior appendages of the male. In these the Cu_2 area is a single row of cells as in Archiargiolestes. Otherwise the wings are distinctly Austroargiolestes as is also the penis.

The Cu_2 area varies in this genus from a single row of cells as in the unnamed species noted above to specimens that have a few double cells in a simple Cu_2 area as in *Argiolestes icteromelas* on to species with three well-developed rows of cells in the Cu_2 area.

Argiolestes minimus is placed in this genus because its wings are distinctly Austroargiolestine though its penis and the superiors of the male are like those of the species of Archiargiolestes.

The genus is intermediate between the very primitive genera such as Podolestes and Archiargiolestes and the more specialized genera such as Argiolestes, Podopteryx, Caledopteryx, Wahnesia, etc. It is primitive in the position of Ac under antenodal two while it is only moderately specialized in the Cu_2 area. This genus and Archiargiolestes suggest that the Argiolestine series of genera beginning in these simply veined genera and ending in the very specialized Burmagiolestes and Allolestes may have arisen in Australia.

Argiolestes Selys, 1862. For *Agrion australis* Guérin from the island of Offack near New Guinea. Several species.

Length:— abdomen 28–38 mm., hind wing 26–32 mm. (*A. selysi* Forster, abdomen 53–54 mm., hind wing 44 mm.).

The history of Argiolestes according to Dr. Calvert, follows:— Guérin (Voyage de la Coquille. Zool., **2**, p. 196), described the species, placing it in the genus Agrion. Rambur (Histoire naturelle des insectes. Névroptères, 1842, p. 256), described the same specimen, but referred incorrectly to "pl. 10," Guérin, on which there is no figure of this species. De Selys (Synopsis des Agrionines, Legion

Podagrion, described the same specimen, obtained from Dumont d'Urville, 1862, p. 39) but incorrectly refers the original description to Rambur.

The series of Australian species are included in Archiargiolestes and Austroargiolestes. After removing *sidonia* Martin, *aurantiaca* Ris, *obscura* Selys, and *ornata* Selys to Wahnesia, *sarasini* Ris to Caledopteryx, *melanothorax* Selys to Burmargiolestes, *cincta* Selys to Celebargiolestes and *uniseries* Ris to Caledargiolestes there are left in Argiolestes, *australis* Guérin, *pallidistyla* Selys, *rouxi* Ris, *selysi* Forster, and *macrostylis* Ris. *Argiolestes selysi* Forster may be a Podopteryx as it has a slightly richer Cu_2 area than the others and is a giant in size. Forster's description is not detailed enough to settle the question. *Argiolestes macrostylis* Ris may be a Wahnesia. In the origin of M_3 and Rs it appears intermediate between the two genera. According to Ris all the Papuan species of the Selysian genus Argiolestes are congeneric with *australis*.

Wahnesia, which is specialized in the origins of M_3 and Rs, is an offshoot of Argiolestes, while Metagrion is an even more specialized offshoot of Wahnesia. Caledopteryx and Celebargiolestes are specialized offshoots of Argiolestes in other directions.

Caledopteryx Kennedy, 1925. New Caledonia. One species based on *Argiolestes sarasini* Ris.

Length:— abdomen 48 mm., hind wing 39–40 mm. Male inferiors long.

Only Ris's very complete description is available for study. The penis has not been examined. This is a very large Argiolestes (*sensu strictu*) as is shown by the position of Ac under antenodal one. It is not closely related to Podopteryx because there Ac lies under antenodal two which relates Podopteryx to Austroargiolestes. The penes of Austroargiolestes and Podopteryx also show this relationship. The simple stigma also distinguishes it generically from Podopteryx, which has a dilated stigma, as well as the long inferiors of the male.

Caledopteryx sarasini is considered an independent development parallel with Podopteryx.

Celebargiolestes Kennedy, 1925. Celebes. For the single species *Argiolestes cincta* Selys.

Length:— abdomen 34–36 mm., hind wing 30–32 mm. Male inferiors half as long as superiors.

I have had the privilege of studying a male specimen determined by Ris (Williamson's collection). This is a beautiful insect with the wing developed by increased length between nodus and apex. It is special-

ized in the unusual squareness of all the cells in the apical half of the wing so that the long extra sectors are very evenly curved. The great number of postnodals, 34–40, indicates this development of the distal half of the wing. It belongs in the Papuan group of genera in which Ac lies under antenodal one.

Wahnesia Forster, 1900. New Guinea and Bismarck Archipelago. Six species.

Length:— abdomen 30–38 mm., hind wing 28–30 mm. Male inferiors rudimentary.

This genus includes *kirbyi* Forster and *montivagans* Forster, the first of which is the type. From descriptions, it appears also to include *ornata* Selys, *obscura* Selys, *sidonia* Martin, all of New Guinea and all placed in Argiolestes; also *Argiolestes aurantiaca* Ris from the Bismarck Archipelago at the eastern end of New Guinea. All of these species are modified Argiolestes in which the wing has become specialized by the origins of M_3 and Rs having moved distad. *Argiolestes macrostylis* Ris appears to be intermediate in this character between Argiolestes (*sensu strictu*) and Wahnesia. Ris (Odonata Neu-Guinea, 1913) thinks these genera should not be separated.

Ris thinks also that Wahnesia cannot stand as a generic name because Forster's description is not adequate. However, Forster distinguished *kirbyi* from *montivagans* in his notes on the genus and deposited the types in the Hungarian National Museum. As the stability of a scientific name does not depend on the length or quality of the specific description, the genus will stand unless it is merged into Argiolestes.

This genus is close to Metagrion from which it differs in the less movement distad of the origins of M_3 and Rs. It is also close to Burmagiolestes, but differs in the normal quadrangle. It thus appears to be the stock from which have developed Metagrion, Burmargiolestes, and Allolestes.

Burmargiolestes Kennedy, 1925. Northern British India and Burma. For *Argiolestes melanothorax* Selys.

Length:— abdomen 30–38 mm., hind wing 25–27 mm. Male inferior appendages short. Only the literature available.

This genus is a member of the Argiolestes series as is shown by the pronounced stigmatic brace vein. It is related to the Papuan genera, Argiolestes, Wahnesia, and Metagrion rather than the Australian genera Austroargiolestes and Archiargiolestes, because Ac is under antenodal one. It differs from Wahnesia in having only one postquadrangular cell which brings the apex of the quadrangle to the level of the nodus.

It is related to Allolestes of the Seychelles in which the lengthening of the quadrangle has gone a step farther. As Burmargiolestes has two rows of cells in the Cu_2 area and Allolestes but one row, it would seem that the latter genus had derived its simple Cu_2 area by reduction from a double rowed Burmargiolestes type.

Allolestes Selys, 1869. Seychelles, two species.

Length:— abdomen 25 mm., hind wing 20 mm. Male inferiors long.

A fragmentary male (Plate, fig. 7) in Williamson's collection has been studied.

This is undoubtedly related to Burmargiolestes, but with the same specialization of a long quadrangle more extravagantly developed. It is a Gondwana species sprung from India stock. When one of the most specialized species of the subfamily is stranded in the Seychelles by the sinking of Gondwana, it shows how old the subfamily really is.

The other possibility is that Burmargiolestes and Allolestes may be more closely related to Neurolestes and Nesolestes than to the Argiolestes series of genera. All four genera are similar in the retracted nodus which lies close to the apex of the quadrangle. All four have a Gondwana distribution from Africa and Madagascar to the Seychelles and India.

Paraphlebia is not related to these though it has a similarly retracted nodus; it differs in having a short Cu_2, in extra sectors between M_1 and M_{1a} as well as between Cu_1 and Cu_2.

The penis is the same as in Podolestes, Archiargiolestes, Nesolestes, Neurolestes, and Riphidolestes.

Tatocnemis Kirby, 1889. Madagascar. One species.

Length:— abdomen 50 mm., hind wing 34 mm. Male inferiors short.

This strange species has been associated with the Platycneminae because it has the complete suppression of all extra sectors other than M_{1a}, however it possesses the following characters which exclude it from that family:—

1. Ac lies at the level of the first antenodal. In all known Platycneminae it lies between the two.
2. Petiolation reaches to the apex of the quadrangle.
3. Male superior appendages semicircular, forcipate with widened apices, a type never found in the Platycneminae.
4. Penis shaft with long hairs or spines, which never occur in the Platycneminae.
5. Penis lobes directed caudad before turning cephalad. In the Platycneminae they are always directed cephalad.

This is too large a list of antagonistic characters to permit the retention of Tatocnemis in the Platycneminae. Curiously enough these characters are all just as positively Megapodagrionine characters as they are not Platycnemine. The answer to this riddle is that Tatocnemis belongs in the Megapodagrioninae near the South American group of genera. In the lack of sectors and the origin of M_3 and Rs Tatocnemis appears to be related to the Heteropodagrion-Oxystigma series, but it probable comes off this branch of the South American group of genera below any of the existing genera. Its normal stigma suggests great primitiveness, but the loss of sectors suggests relationship to Heteragrion and its relatives.

Tatocnemis is one of the genera that appear to show a former land connection between Africa and South America.

Nesocnemis Selys, 1891. Madagascar.

As Ac is under antenodal one, this is related to Tatocnemis, if it is not that genus, rather than to Prionocnemis as suggested by Selys. All three genera have the edge of the wing sinuate. As Selys, in his discussion of the relationships of Nesocnemis, does not mention Kirby's description of Tatocnemis (1889), he probably did not know of it. This is probably Tatocnemis.

Protolestes Forster, 1899. Madagascar. One species, *fickei*. Known only from Forster's description.

Length:— Female, abdomen 27–28 mm., hind wing 24–25 mm. Male unknown.

Forster's description suggests a link connecting Tatocnemis with the other Megapodagrionines. His description mentions but one extra sector other than M_{1a}, this being one that begins two cells before the stigma and that lies between M_{1a} and M_2. Ac lies under antenodal one as in Tatocnemis, but M_3 arises one cell before the subnodus and Rs 2–3 cells beyond the subnodus. These characters make this a Megapodagrionine, but a type slightly less specialized than Tatocnemis as it still has one extra sector other than M_{1a} and the origin of M_3 and of Rs is less modified. This is probably a genus intermediate between Tatocnemis and the less specialized genera of the subfamily.

The extremely oblique stigma may or may not show relationship to the oblique stigmaed Megapodagrioninae of South America.

LIMITS OF THE MEGAPODAGRIONINAE.

The Megapodagrioninae may be defined as follows:—

Zygoptera with two antenodals (except in Trineuragrion, Neurolestes, Thaumatoneura, Phenacolestes, Dysagrion, and Neuragrion); M_3 and Rs arise at or within one or two cells of the subnodus (except M_3 in Riphidolestes, Phenacolestes and Dysagrion); stigma short, surmounting 1–4 cells (except in Melanagrion 5 and Thaumatoneura 8); quadrangle with acute apex (except in Thaumatoneura); one or two extra sectors besides M_{1a} (except in Tatocnemis). Male appendages forcipate with dilated apices, inferiors frequently rudimentary. Tropical and subtropical species.

The limits of the Megapodagrioninae are thus much more closely drawn than previously. The key shows what genera have been included, and the more notable exclusions are noted below.

Philoganga Kirby, 1890, for Anisoneura Selys (1859, p. 444), which stands between the Megapodagrioninae and the Amphipteryginae was given subfamily rank as the monogeneric subfamily Philoganginae of the Agrionidae, because of the unusual combination of venational characters. The long narrow wing of this curious Himalayan relic can be accounted for if we consider Philoganga as having developed from an ancestor like Hypolestes (Ortholestes) or Podolestes. Philoganga is very large, being one of the heaviest bodied Zygopters known. To support this very heavy body the wing area had to be greatly increased. This appears most easily done by simply lengthening all the longitudinal veins. This makes a paddle-like, narrow, and awkward wing with none of the fine adjustments in curved veins, but it answered the purpose of support in the early history of the Zygoptera before modern birds compelled better flying organs in Odonata.

The lengthening of Sc has placed the nodus (apex of Sc) seven or eight cells distad. The lengthening of M_{1-2} has carried the base of Rs distad a cell or two, while the origin of M_2 has passed farther distad than the nodus itself. The many extra antenodals have been necessary to support the long Sc.

An alternate classification would be to place Philoganga in the Amphipteryginae. It does not belong there because M_3 and Rs do not arise close enough to the arculus.

This awkward giant has survived to the present day through some special mode of living or by the protection given by some very special habitat.

Philosina Ris, 1917, from the Province of Fokien, China, which is considered more primitive than any living Amphipterygine, Polythorine, or Agrionine has been given subfamily rank as the Philosininae of the Agrionidae. It is another giant Zygopter that has developed a large wing, with but little modification or adjustment of the plan of the wing of its small ancestor.

The long Amphipterygine stigma removes it from the Megapodagrioninae. The origin of M_3 and Rs nearer the subnodus than the arculus removes it from the Amphipteryginae. The penis with slender, doubly curved, recurrent lobes is very much like that of the Polythorinae and that of Caliphaea, the most primitive Agrionine. With its short Cu_2 it looks like a Megapodagrionine wing in which the area between the nodus and stigma had been enriched to increase the area for the very heavy body. It is possible that the stigma was lengthened in this same process, otherwise it stands between the Megapodagrioninae and Amphipteryginae.

Perilestes Selys, 1862, Synlestes Selys, 1869, and Chlorolestes Selys, 1862, and the genera Episynlestes Kennedy, 1920, and Euchlorolestes Kennedy, 1920, have been removed to the Lestidae on the ground of penis characters. The apical segment is lacking in all three as it is in all Lestidae. Tillyard, 1914, had already recognized the Lestid relationships of these on venational grounds.

The Lestidae may be revised as follows:—

Perilestinae	Perilestes Selys.
Synlestinae	Synlestes Selys, Episynlestes Kennedy, Euchlorolestes Kennedy, Chlorolestes Selys.
Megalestinae	Megalestes Selys, Chalcolestes Kennedy.
Lestinae	Lestes Leach, Africalestes Kennedy, Ceylonolestes Kennedy, Austrolestes Tillyard, Superlestes Williamson, Archilestes Selys, Cyptolestes Williamson, Sympyena Charp., Platylestes Selys.

The male appendages of Perilestes are very obviously Lestid. The penis of Perilestes lacks the apical segment, which is the main character of the family. The venation of Perilestes, though, needs some explanation to adjust it to this family. However, it does not conflict if we consider Perilestes the most primitive member of the Lestidae, and from it derive the type of venation found in the modern genera of the Lestinae. This reverses the older idea of specialization in Zygopterous venation, this derivation of a broad, richly veined wing with little petiolation from a narrow, "reduced" wing that has an extraordinarily

long petiole. However, this derivation of the modern Lestes wing from the greatly reduced wing of Perilestes appears to be our best explanation of the curious location of the "oblique vein" in the apex of the Lestes wing.

When the Perilestine wing developed to its modern breadth in the Lestes wing all the forks retreated basad as the wing widened except that of Rs which was left behind in the apical half of the wing as the oblique vein. It, of course, occurs normally in the apical half of the wing in the ancestral Perilestes because here is the original condition of the Lestid wing in which none of the forks have as yet moved basad. Chlorolestes and Synlestes represent an intermediate condition between Perilestes and Lestes.

Lestoidea Tillyard, 1913a, is a very aberrant Megapodagrionine, but is left entirely out in this study because it is so strange, its place cannot be stated with any degree of certainty until the penis is studied, and may be not then. Probably it is best to give it a separate subfamily as did Tillyard (Legion Lestoidea) the Lestoidinae. The apical half of the wing is distinctly Megapodagrionine in the short stigma and the extra sector. Except for the origin of M_3 and Rs the base of the wing could be also Megapodagrionine in which the Cu_1 and Cu_2 veins were greatly reduced. The male appendages are distinctly Megapodagrionine. With all the other characters against it the reduced Cu_1 and Cu_2 do not show any relationship to the Protoneurinae. The appendages and the general appearance of the wing do not indicate any close relationship to the Lestidae.

Hemiphlebia Selys, 1869, has been given full family rank as the Hemiphlebidae because it combines the characters of the Anisozygoptera with characters of the Agrionidae, Lestidae, and Coenagrionidae, wherefore it would appear to be one of our most primitive Zygoptera.

Selys, while noting the strange characters of this genus, placed it at the apex of his system of classification. Dr. Needham and Dr. Munz both discussed it, but each placed it high in the Coenagrioninae and attributed its venational peculiarities to reduction. It was not until it was necessary to determine the place of this insect among the Coenagrionine genera that its great primitiveness was recognized. This discovery meant a complete revision and readjustment of the organization of the Zygoptera and many days were spent in checking over the probable biological history of the group, the venation, and the fossil record.

The venation of Hemiphlebia is primitive in the very irregular arrangement of the crossveins and in the acute forks at the origin of

M_2 and M_3. This is not the usual specialized Odonate fork in which the bases of M_2 and M_3 extend out from M_1 at nearly right angles and then curve outward, but it is a more primitive fork such as occurs in other Neuropteroid insects. The stigma shows no specialization, being merely a thickened cell. The nodus has a remarkably small amount of specialization, being flat and similar to that in the less specialized Anisozygoptera. The open quadrangle may or may not be a primitive character. If it shows relationship to Chorismagrion it may be primitive.

The genitalia of the male second segment are interesting in that the anterior hamules are less developed than in any other Zygopter. The penis is remarkable for the great abundance of shaft hairs which cover its whole ventral surface. A similar condition is found only in some Megapodagrioninae and in some Agrioninae. This character alone excludes Hemiphlebia from the Coenagrionidae. The penis is peculiar in having a fossa in the ventral surface of the second segment. This pocket is similar to that found in the Lestidae and is the only case where such a fossa occurs outside the Lestidae.

Tillyard (*in litt.*) places Chorismagrion next to Hemiphlebia in primitiveness. The following relationship of the two genera is suggested.

Hemiphlebidae
Hemiphlebinae . . . . . *Hemiphlebia mirabilis* Selys.
Chorismagrioninae . . . . *Chorismagrion risi* Morton.

Chorismagrion Morton, 1914, has a subfamily of its own, but it is difficult to decide where such a specialized insect should be classed without having first studied the insect itself. Only Morton's description is available. The placing of this as a member of the Hemiphlebidae is only a suggestion with several facts against it. First the wing has none of the very primitive characters of Hemiphlebia such as the simple stigma, the acute forks of M_2 and M_3, and the irregular cells. The open arculus may be only a convergence. The appendages indicate an insect among the more primitive families rather than a member of the Coenagrionidae.

Phenacolestes Cockerell, 1908, and Dysagrion Scudder, 1878, have been included in the Megapodagrioninae as being distantly related to Paraphlebia and Thaumatoneura as well as to Lithagrion, Melanagrion, Miopodagrion, and Eopodagrion Cockerell, 1920. This whole group of North American genera is related to the Oriental genera rather than to the nearer South American genera.

Tatocnemis Kirby, 1889, and Nesocnemis Selys, 1891, which is probably a synonym of the former, have been included in the Megapodagrioninae. These are Megapodagrionines that have lost all extra sectors except M_{1a}.

Dr. Ris has kindly sent me photographs of two new genera of Megapodagrioninae from South China and a third new genus from Luzon. One of the new genera from South China is obviously related to Burmargiolestes while the other appears to be Amphypterygine, though it has characters that seem to place it between the two subfamilies. The species from Luzon is a generalized and primitive form of the Argiolestes series.

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EXPLANATION OF PLATE.

Fig. 1.— *Archiargiolestes pusillus.* Armadale, W. Australia. December, 1906. R. J. Tillyard. (M. C. Z. Coll.).

Fig. 2.— *Archiargiolestes pusillissimus.* W. Australia. Thorey. (M. C. Z. Hagen Coll.).

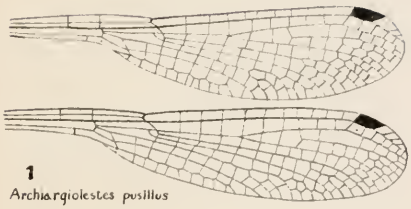
Fig. 3.— *Caledargiolestes uniserics.* New Caledonia. (From Ris, Nova Caledonia, Sarasin & Roux, Zool., 1915, **2**, l. 1, p. 62, fig. 5).

Fig. 4.— *Austroargiolestes minimus.* Waroona, W. Australia. G. F. Berthoud. (M. C. Z. R. J. Tillyard).

Fig. 5.— *Celebargiolestes cincta.* Tokalla Mts., Celebes, 1915. I. Rolle. (E. B. Williamson Coll.).

Fig. 6.— *Burmargiolestes melanothorax.* Darjiling, India. (From Laidlaw, Rec. Indian mus., 1917, **13**, pl. 15, fig. 1.).

Fig. 7.— *Allolestes maclachlani.* Seychelles. (E. B. Williamson Coll.).



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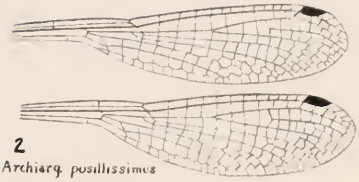
Archiargiolestes pusillus



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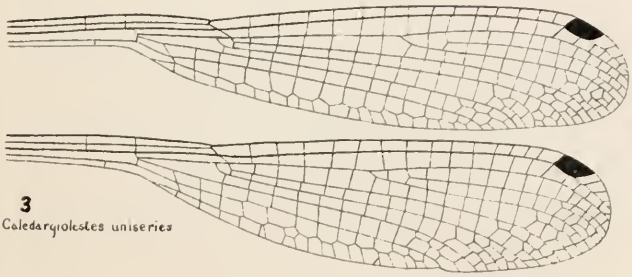
Archiarg. pusillissimus



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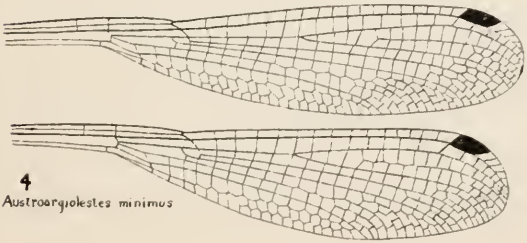

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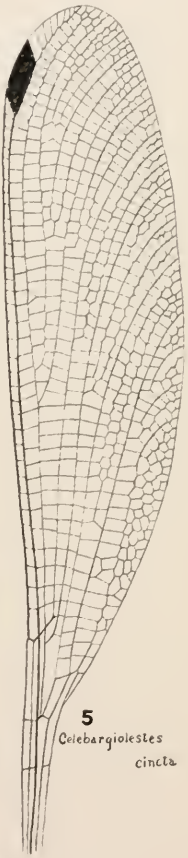
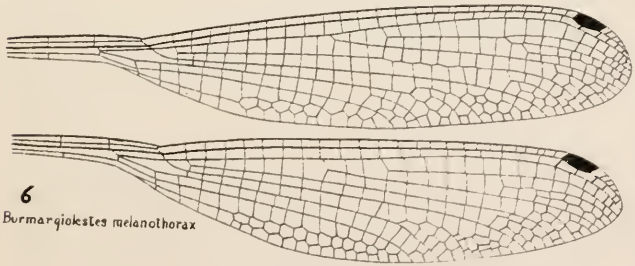
Austroargiolestes minimus



5
Celebargiolestes
cincta



6
Burmargiolestes melanothorax

7
Allolestes maclachlani

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LXVII. No. 8.

NEW SPECIES OF FOSSIL CORALS FROM THE DOMINICAN REPUBLIC.

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CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
November, 1925.

No. 8.— *New Species of Fossil Corals from the Dominican Republic.*

By Thomas Wayland Vaughan and John Edward Hoffmeister.

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Introduction.

While engaged on a geological survey of the Dominican Republic between 1869 and 1871, Mr. W. M. Gabb made a collection of corals which was given to the Museum of Comparative Zoölogy (Report on Radiata, by L. F. Pourtalès. Ann. rept. M. C. Z. for 1875, 1876, p. 28) and some years ago this collection was lent to the U. S. N. M. for study. It contained several new species which were described in manuscript by T. W. Vaughan, but the descriptions were not published.

After the descriptions above mentioned were written the U. S. N. M. received from the Dominican Republic large collections, the principal one of which was made by T. W. Vaughan and C. Wythe Cooke during field-work on a geological survey of the Republic. A small, but valuable collection had previously been received from Dr. Carlotta J. Maury. The later collections contained better specimens of some species than the Gabb collection, therefore, type specimens have been selected from the better material. After this was done, there still remained five species which have not been recognized in the later

collections. The present paper contains descriptions of the nine new species represented in the Gabb collection.

All of the descriptions except that of *Stylophora monticulosa* were written entirely by the senior author and the species names, except *S. monticulosa*, should be so accredited. The junior author has written the description of the cotypes of *S. monticulosa*, added notes on some of the other species, and had the paper prepared for press.

DESCRIPTIONS OF GENERA AND SPECIES.

Smilotrochus Milne-Edwards and Haime.

Hitherto no species of Smilotrochus has been described from America, but *Flabellum ? merriami* Nomland (Corals from the Cretaceous and Tertiary of California and Oregon. Bull. Dept. geol. Univ. Calif. Publ., 1916, **9**, p. 62, pl. 3, fig. 1–4, pl. 4, fig. 17) from the Eocene of the "lower Tejon group," is probably referable to this genus. The only reason for doubt is that the cross section of the corallum (*op. cit.*, Plate 4, fig. 17) shows what appear to be vestiges of a false columella; but the presence of a weakly developed columella formed by septal processes would not necessarily exclude the species from Smilotrochus.

Smilotrochus ? dominicensis, sp. nov.

Plate 1, fig. 1, 2.

Description of holotype.— M. C. Z. 9,266. Corallum small, cuneiform, free, no trace of a pedicel, lower edges with thin crests, which do not extend to the calicular margin, the width of the base nearly equals the greater diameter of the calice. Greater diameter of calice, 4.5 mm.; lesser, 2.5 mm.; height of corallum, 4 mm.

Wall naked, upper edge thin. Costae distinct, not very prominent, subequal in size.

Septa, thin, rather distant, upper margins slightly exsert, in four complete cycles, the members of the first and second cycles equal, those of the third shorter and thinner, those of the fourth very small.

Calice very deep, no trace of a columella could be found.

The generic identification of this coral is doubtful, since Smilotrochus has an epitheca similar to that of Flabellum and Placotrochus. The wall of *S. ? dominicensis* is naked.

Locality.— Dominican Republic, without specific locality. Gabb collection.

Placocyathus Milne-Edwards and Haime.

The genus Caryophyllia appears to grade into Placocyathus. It seems that Placocyathus has been derived from Caryophyllia through the extension of the greater transverse axis of the calice and the conversion of a columella composed of twisted axial laths into an elongate axial lamella. Four species of Placocyathus from the West Indies possess columellae of trabecular constitution. This character shows their close kinship with Caryophyllia, but the fact that the columellae are lamellate in form, as well as other differences, places them with Placocyathus. *P. maoensis* and *P. cristatus* and two other species of the same group described in manuscript nearly ready for publication are characterized by their small size, their flabellate form, and by having a columella, which although lamellate is really formed of axially compressed coalescent trabeculae.

Placocyathus maoensis, sp. nov.

Plate 1, fig. 3–10.

Description of holotype.— U. S. N. M. 353,644. Corallum compressed, straight, attached by a small basal pedicel, about 1 mm. in diameter and about 1 mm. tall, just above which are slight lateral crests that become obsolete at a height of 6 mm. above the tip of the base. Height of corallum to upper edge of the wall 16 mm.; greater diameter at calice 14.5 mm.; lesser diameter at calice 8 mm.

Wall stout, solid, rather finely costate. Costae correspond to all septa, subequal in size, alternately larger and smaller, or every fourth costa may be slightly more prominent than the intervening costae; fourteen to fifteen costae within 5 mm. Costal edges rather acute, transversely wavy; granulations on the summits and sides. Porcellaneous epithecal deposit forms a succession of encircling bands which in places entirely obscure the costae. This deposit was evidently formed by the inner surface of the soft tissues that extended over the calicular edge, and was not formed at the lower margin of the edge zone (as in Antillia and Syzygophyllia). The successive bands appear to mark growth stages.

The dimensions of the calice are given above; depth below the upper edge of the wall 3 mm., the margins of largest septa were probably exsert about 1.5 mm., but have been broken away.

There are seventy-eight septa, nineteen of which are thicker than the others and extend either to or almost to the columellar fossa; except in one loculus there are between each pair of largest septa, three septa, the middle one of which is the larger, and moderately thick; the members of the last cycle in the

different groups are small, both thin and relatively short. The general arrangement of the septa in three sizes is very conspicuous. The exception noted above is near one end of the longer calicular axis where there are five septa between two of the largest size. The upper margins of the septa are broken, but the inference that they are entire seems warranted, particularly as the palar edges are entire. Inner edges of the largest septa are vertical. Septal faces beset with fine, conical granulations, which are arranged in curves parallel to the septal margins.

Pali are well developed before the septa of the intermediate size, they project about 1.5 mm. above the top of the columella, and range from about 0.75 to 1 mm. in width; their upper edges are arched and entire, both the inner and outer edges vertical; a deep notch between a palus and its corresponding septum, which shows a distinct thickening at the outer side of the palar notch. Palar faces with somewhat larger granulations than the septal faces.

Columella prominent, compressed, elongate in the longer axis of the calice, composed of curled, fused axial trabeculae.

Locality and geologic occurrence.— Dominican Republic, Station 7,785, Cercado de Mao, Bluff 1. Miocene. Miss C. J. Maury.

There is a large number of specimens of this species in the U. S. N. M. collected by Miss Maury and by Vaughan and Cooke from the Dominican Republic.

Gabb collected specimens, without definite locality, which are in the M. C. Z. One of the Gabb specimens (M. C. Z. 9,267) is small, not so compressed, and with a smaller greater calicular diameter. The height of the corallum is 14.5 mm.; it has a greater diameter of 10.5 mm., and a lesser diameter of 8.5 mm. There are fifty-seven septa which are arranged in the usual three sizes. In other respects its characteristics are those of normal specimens. It is shown on Plate **1**, fig. 7, 8. Another specimen (Plate **1**, fig. 5, 6) obtained by Gabb was originally placed in a separate species which was to be described as new. It has subsequently, however, been referred to *P. maoensis*, since it seems to represent only a variation of it. It differs from the typical form in that the fused axial trabeculae are finer. Several specimens similar to this were collected by Miss Maury and Vaughan and Cooke. The third Gabb specimen (Plate **1**, fig. 9, 10) is somewhat distorted.

Placocyathus cristatus, sp. nov.

Plate 1, fig. 11–14.

Description of holotype.— U. S. N. M. 353,643. Corallum compressed, flabellate, curved in the plane of the longer axis of the calice; originally attached by a small base, above which there is a more prominent crest on the convex curvature and a lesser prominent crest on the concave curvature of the corallum, both crests becoming obsolete at a vertical height of about 17 mm. above the base. Vertical height of corallum to top of wall about 21 mm., largest septa exsert about 2.5 mm.; greater diameter at calice 23 mm.; lesser diameter at calice 14 mm.; depth of calice from the top of the columella to top of wall about 4 mm.

Wall strong even at its upper edge, solid, costate. Costae correspond to all cycles of septa, rather low except where they form the crests above noted, alternately larger and smaller or every fourth may be slightly more prominent than the intermediates. Costal edges usually acute, in places more or less rounded, more or less transversely wavy and granulate, costal sides sloping, with some granulations, and with fine raised lines. Porcellaneous epitheca form girdling bands that in places entirely obscure the costae.

There are 106 septa, which, according to the conventional method of computing cycles, would represent five complete cycles and ten members of the sixth cycle. In general about twelve septa extend to the columellar fossa and are slightly longer and thicker than the tertiary septa, while the quaternaries and quinaries are smaller according to cycle. The sixth cycle is represented in the half systems next the ends of the longer transverse axis of the calice. In one quarter system there are no quinary septa. The margins of the primary and secondary septa are exsert as much as about 2 mm.; those of the tertiaries are exsert about 1.5 mm.; those of the quaternaries slightly lower; while those of the quinaries are exsert only about 1 mm. The margins of the septal arches are entire; the inner margins of the largest septa are smooth, slightly thickened, and perpendicular. The septal faces bear raised lines along which are small granulations more or less fused into rows; the granulations also show rather vague arrangement in curves parallel to the septal edges. The raised lines and the associated granulations are similar to those seen in some species of Flabellum. The interseptal loculi are open in the upper part of the corallum but near the base of the corallum they are solidly filled with stereoplasm.

Steeply arched, prominent pali are present before the quaternary septa; smaller pali may stand before the tertiaries, but this is doubtful as the specimen is damaged.

Columella prominent, essential, lamellate, but appears to have been formed of several more or less wavy trabeculae that are flattened and fused in the plane of the long axis of the calice, and possesses characters intermediate between those of Caryophyllia and Placocyathus.

Locality and geologic occurrence.— Dominican Republic, Station 7,785, Cercado de Mao, Bluff 1. Miocene, Gurabo formation. Miss C. J. Maury.

A specimen collected by Gabb in the Dominican Republic (M. C. Z. 9,269) seems to belong to this species. After the specimen was photographed it was cut across and each exposed surface was polished. The interseptal loculi become completely filled with stereoplasm, and there is no trace of dissepiments. The columella is composed of a series of axial plates arranged along the longer calicular axis, and simulates what would result if the columellar trabeculae of Caryophyllia were developed in one plane. The filling of the interseptal loculi with basal deposit obscures the pali, but they appear to have been wide before the tertiary septa. The inner ends of the long septa are thickened. The costae on this specimen are more rounded than in the type.

Stylophora monticulosa, sp. nov.

Plate **1**, fig. 15, 16. Plate **2**, fig. 1–3, 5.

Stylophora affinis var. 2 Duncan, Quart. journ. Geol. soc. London, 1863, **20**, p. 27.

Description of cotypes.— U. S. N. M. 353,642. Corallum forming long, crudely cylindrical branches, slightly compressed. The fragment of the branch described measures 75 mm. in length, is 20 mm. in diameter at the basal end and 18 mm. at the tip. Thus there appears to be very little narrowing of the branch toward the top. In another fragment which includes the tip the branch measures about 17 mm. in diameter at a distance of 50 mm. from the end and about the same at the blunt tip.

The sides are covered with verrucae without definite arrangement, although in places they form parallel rows running the length of the branch. In places the verrucae are joined but usually the distance from the crest of one to that of another is from 5 to 7 mm. They are rather tall, many attaining a height of 3 mm. and a few reaching even 5 mm. Usually there are more verrucae on one side of the branch than on the opposite side.

The calices are 0.5 to 0.75 mm. in diameter, fairly deep, and usually slightly farther apart than their own diameter, although many are closer together. The margins of many calices are slightly raised and eighteen short, granular costae appear. The coenenchyma is covered with granulations which may or may not be arranged in rows. A slight but distinct groove defines the limits of the individual corallites.

The septa are six in number and run to the columella. In some calices a rudimentary second cycle is seen. Columella, a style, rounded at the top and in some calices reaching to nearly the top of the calice.

The above description is based on cotypes collected by Vaughan and Cooke, Station 8,556.

The following description is based on three paratypes collected by Gabb in the M. C. Z. 9,270–9,272.

Corallum forming small rounded or compressed branches which apparently in some instances may be lobate around the upper ends; numerous monticules varying from 2 to 5 mm. in diameter at the base and attaining a height of about 2 mm. are scattered over the surface. The calices are small, moderately deep, the usual diameter 0.5 to 0.75 mm. They have no recognizably definite arrangement and are separated by about their own diameter. Around many calices there is a very slightly raised calicular rim, which is ornamented by about eighteen costae, which may be very short or may extend from one calice to the next. The coenenchymal surface between calices is partly costate and partly granulate; where it is perfect, usually a faint elevated line marks the limits of adjoining zoids. The cross section of a branch shows a spongy axis, outside of which the coenenchyma between the corallites is very solid; along the corallite cavities are dissepiments, about 6 in 2.5 mm. or slightly less than 0.5 mm. apart.

There are six septa that extend to the columella; these are decidedly thicker at the wall, thin in their median portion, and somewhat thicker around the columella; the second cycle is rudimentary or absent. Columella rather stout, upper end roundish.

Locality and geologic occurrence.— Dominican Republic, Province of Monte Cristi, right bank of Rio Gurabo. Middle Miocene, Gurabo formation. Vaughan and Cooke. Dominican Republic, without specific locality. Miocene. Gabb collection.

Stylophora monticulosa is the same as Duncan's *Stylophora affinis* var. 2. The type specimen of the variety is 12,905, collection of the Geol. soc. London. There are also two other specimens without number. Specimen 12,905 is figured on Plate **2**, fig. 3; note especially that the upper lip of the calice may be more prominent than the lower. It is close to *Stylophora affinis*.

A description of this species has been long in manuscript. It has verrucae similar to those of many species of Pocillopora and some calices have plug-like floors in their bottoms, but in general the six primary septa are completely developed and extend to the columella. There are no secondary septa. The columella is usually a low, pointed style. *S. monticulosa* is interesting as it seems to indicate that Pocillopora has been derived from Stylophora by retrogression of the septa.

Some of the specimens collected by Vaughan and Cooke from the Dominican Republic (Station 8,735), province of Monte Cristi, on

left bank of Rio Gurabo, about 3.4 kilometers below Gurabo Adentro, in the Gurabo formation of Middle Miocene age have branches which in places measure 40 mm. in diameter.

Asterosmilia Duncan.

There are seven known fossil species of Asterosmilia from the West Indies. Five of these have already been described, namely *A. abnormalis* (Duncan), described as *Trochocyathus abnormalis*, Quart. journ. Geol. soc. London, 1864, **20**, p. 26, pl. 2, fig. 4a–4c. *A. hilli* Vaughan, Bull. 103 U. S. N. M., 1919, p. 355, pl. 80, fig. 4, 5, 6, 6a. *A. pourtalesi* Duncan, Quart. journ. Geol. soc. London, 1873, **29**, p. 553, pl. 19, fig. 4. *A. exarata* Duncan, Philos. trans. Royal soc. London, 1868, **157**, p. 653, pl. 32, fig. 5, and *A. profunda* (Duncan), described as *Trochocyathus abnormalis*, Quart. journ. Geol. soc. London, 1864, **20**, p. 26, pl. 5, fig. 3a–3c.

All of these species have cornute coralla. The two new species, *A. compressa and A. duncani*, have flabelliform coralla.

Asterosmilia compressa, sp. nov.

Plate **3**, fig. 3, 4.

Description of cotypes.— M. C. Z. 9,273–9,276. Corallum compressed, flabelliform and straight or very slightly curved in the plane of the shorter transverse axis of the calice; attached by a short pedicel, with crests above the pedicel on both edges of the corallum. Calice elliptical.

Measurements and number of septa of Asterosmilia compressa.

Specimen	Greater diameter of calice	Lesser diameter of calice	Height of corallum	Number of septa
M. C. Z. 1 [1]	about 20 mm.	9 mm.	about 22 mm.	about 108
M. C. Z. 2	23 mm.	10 mm.	22 mm.	about 114
M. C. Z. 3 [2]	about 22	about 10.5	27 mm.	about 112
M. C Z. 4 [3]	26 mm.	9.5 mm.	35 mm.	about 135

[1] Base and one end of calice broken.
[2] One side of calice broken.
[3] Ends of calice broken.

As this species must be compared with *A. abnormalis* (Duncan) the measurements of that species, according to him, are given here.

Specimen	Greater diameter of calice	Lesser diameter of calice	Height of corallum
1	15.3 mm.	12.75 mm.	30.6 mm.
2	20.4 mm.	15.3 mm.	56.1 mm.

From these measurements it will be immediately noticed that this species is relatively much shorter and decidedly more compressed than *A. abnormalis*. The crests above the pedicel seem to be about the same in the two species.

Wall not very thick, may be secondarily thickened from within, externally with some pellicular, porcellanous epitheca. Costae distinct, but low; near the base every fourth one is somewhat more prominent than the intervening three; around the top of the pedicel they may alternate in size. They are granulate along the summits.

Septa from about 100 to 135 in number in adult specimens: five complete cycles, and many members of the sixth. Three or four sizes can usually be distinguished. Usually a rudimentary septum of the fifth or sixth cycle is present between each pair of larger septa. Pali present before the penultimate septa and where the septa are very numerous, as in specimen 4 of the table of measurements for the species, the antepenultimate also. They are not very wide and are rounded above. Septal margins very finely dentate, not truly entire as in Caryophyllia. Endotheca present, but scanty.

Columella very much compressed, lamellate, trabeculate, perforate.

Locality and geologic occurrence.— Dominican Republic. Lower Miocene? Gabb collection.

This species was identified by Pourtalès as *A. anomala*, correctly identified *A. anomala* (*abnormalis* is the proper scientific name) being in the same tray with it.

Asterosmilia duncani, sp. nov.

Plate **3**, fig. 1, 2.

Description of holotype.— M. C. Z. 9,277. Corallum flabelliform, slightly curved near the base, and originally attached by a short, small, pedicel, *above which there are no lateral crests.* In transverse outline, the ends are rounded and medially there is a slight constriction. The dimensions are as follows: — greater transverse diameter, 30 mm. (approximately); lesser transverse diameter in constriction, 18 mm., in widest portion, 19 mm.; height 33.5 mm.

Wall not very thick above, very much thickened by internal deposit near the base of the corallum. Costae low, equal, distant, usually not so wide as the intercostal spaces. There is some very closely applied, pellicular epitheca.

There are fifty-one septa in one half of the calice, the other half is broken, therefore there are a few more than 100 septa in a perfect calice. The fifth cycle is complete and a few members of the sixth are present. A shorter, thinner septum alternates with a larger; it is difficult to distinguish more definite division into sizes; the penultimate seem shorter than those older; in the upper portion of the corallum they are thin and distant, about the thickness of the larger septa. In the lower portion of the corallum all septa are secondarily much thickened. Pali appear to stand before the penultimate septa. Endotheca very well developed. About three dissepiments in an interseptal loculi.

Columella well developed, compressed, minutely vesicular.

Locality and associates.— Dominican Republic. Gabb collection. Occurs with *Asterosmilia exarata* var. *robusta* and *A. compressa* in a blue clay.

This species is most closely related to *A. compressa* but can be distinguished by the absence of lateral crests and by its relatively longer lesser-transverse diameter — the calice is not so compressed as in *A. compressa*.

Antillia dominicensis, sp. nov.

Plate 3, fig. 9. Plate 4, fig. 1, 2.

Description of holotype.— M. C. Z. 9,278. Corallum large, with a small base by which it probably was attached, and above which it expands rather rapidiy. Transverse outline ovoid, with a sinuous margin. Greater diameter of calice 95 mm.; lesser diameter of calice across the axial area 58 mm.; height, 53 mm.

There is no theca proper; remnants of what appears to be epitheca cover in several places the outer ends of the septa. The interseptal loculi are closed externally by dissepiments which are placed very near the distal ends of the septa.

Septa very numerous, 174 were counted, thin, somewhat thicker in the region of the dissepimental wall, some septa flexous. Margins finely dentate, the distal or costal ends also dentate, faces striate, with granulations along the striae. Dissepiments very numerous.

Calice shallow, columella appears to be absent.

Locality and geologic occurrence.— Dominican Republic, without specific locality. Gabb collection.

Specimens were collected in the Mao Adentro limestone by Vaughan

and Cooke on Arroyo las Lavas, U. S. G. S. Station 8,663, and on Rio Mao Adentro. From these specimens it was ascertained that the type is a decorticated specimen of Antillia (Vaughan and others, Mem. 1 Geol. surv. Dominican republic, 1921, p. 152).

Favia dominicensis, sp. nov.

Plate 2, fig. 4, 6, 7.

Description of holotype.— M. C. Z. 9,279. Corallum massive, gently convex on the upper surface. The type specimen is a fragment of a corallum, with a maximum thickness of 47 mm.; length, 71 mm.; breadth, 53 mm.

Calices shallow, oblong, of irregular shape. The smallest calice, greater diameter, 7 mm.; lesser, 6 mm.; the longest calice, greater diameter, 12 mm.; lesser 6 mm. The long calices seem to be dividing. They are separated by strongly costate, vesicular exotheca, 2 mm. across. The costae are thick, separated by spaces about equal to their thickness, and correspond to all septa, except where the last cycle is very rudimentary.

Septa thin; in the smallest calice there are twenty-eight, about ten of which are rudimentary; in the largest, about forty-two, about nine of which are rudimentary. These numbers indicate that in the fully developed calices the fourth cycle is not quite complete. Of the septa in the largest calices about eighteen, or the primaries and secondaries and one half the tertiaries reach the columella. The septal margins are, unfortunately, all broken; the septal faces show low ridges running obliquely upward from the wall to the columella, with granulations scattered along their course, and processes from the inner septal edges form the columella. It therefore seems probable that the upper margins may be finely dentate.

Thin endothecal dissepiments well developed. Between the outer limits of the corallites are subparallel, transverse, thick exothecal dissepiments whose outer ends droop downward and overlap, the overlapping ends forming the corallite walls. The corallite walls are, therefore, of dissepimental origin.

Columella, rather poorly developed, trabecular.

Locality.— Dominican Republic. Gabb collection.

The reference of this coral to the genus Favia may be doubted, as there is no distinctly developed "pseudotheca"; it presents some superficial resemblance to *Favia leptophylla* Verrill from Brazil.

Vaughan and Cooke collected some specimens in the Province of Santiago, Stations 8,663 and 8,531, the Mao Adentro limestone of Miocene age, which have been referred to this species.

Thysanus crassicostatus, sp. nov.

Plate 3, fig. 5–8.

Description of holotype.— M. C. Z. 9,280. The species is based on a single specimen which is split along the longer axis of the calice and the proximal end is broken off. The shape is indicated by the figures. The dimensions of the specimen are: — length, at calicular edge, 65 mm.; width at margin of calice about 40 mm.[1]; height, 32 mm.

The wall is stout at its upper edge, very thick and solid lower down. If epitheca were present, it has been eroded away. Costae well developed, subequal or alternately larger and smaller. Slightly below the upper edge of the calice in 63 mm. Fifty-nine costae were counted. They are coarse, tall, especially in their upper portion, their margins strongly and coarsely dentate, in places they are represented by stout spines.

The septa correspond in number to the costae. They are thicker in the wall, there forming a pseudotheca. Both endothecal and exothecal dissepiments. The calice is deep, approximately 20 mm. Columella, lamellar.

Locality.— Dominican Republic, without specific locality. Gabb collection.

[1] This measurement was obtained by holding the flat side of a ruler against the perpendicular inner ends of the largest septa, and measuring at the margin of the calice from the outside of the corallum to the ruler. The measurement thus obtained was doubled.

EXPLANATION OF THE PLATES.

PLATE 1.

PLATE 1.

Fig. 1.— *Smilotrochus ? dominicensis* Vaughan. Type. Side view. × 4.
Fig. 2.— Same, calicular view. × 4.
Fig. 3.— *Placocyathus maoensis* Vaughan. Holotype. Side view. Natural size.
Fig. 4.— Same, calicular view. × 2.
Fig. 5–8.— Same. Gabb collection.
Fig. 9, 10.— Same, distorted specimen. Gabb collection.
Fig. 11.— *Placocyathus cristatus* Vaughan. Type. Miss Maury, coll.
Fig. 12, 13.— *Placocyathus cristatus* Vaughan. Gabb collection.
Fig. 14.— *Placocyathus cristatus* Vaughan. Type. Miss Maury, coll.
Fig. 15.— *Stylophora monticulosa* Hoffmeister. Cotype. Vaughan and Cooke, coll.
Fig. 16.— *Stylophora monticulosa* Hoffmeister. Miss Maury, coll.

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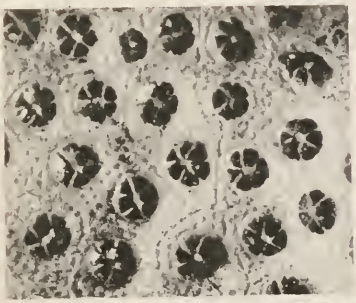
PLATE 2.

PLATE 2.

Fig. 1–3.— *Stylophora monticulosa* Hoffmeister. Gabb collection.
Fig. 4.— *Favia dominicensis* Vaughan. Type. Upper surface of corallum. Natural size.
Fig. 5.— *Stylophora monticulosa* Hoffmeister. View of the original specimen of *Stylophora affinis* Duncan var. 2. Natural size.
Fig. 6.— *Favia dominicensis* Vaughan. Type. Calices. × 2.
Fig. 7.— Same, longitudinal section. × 2.



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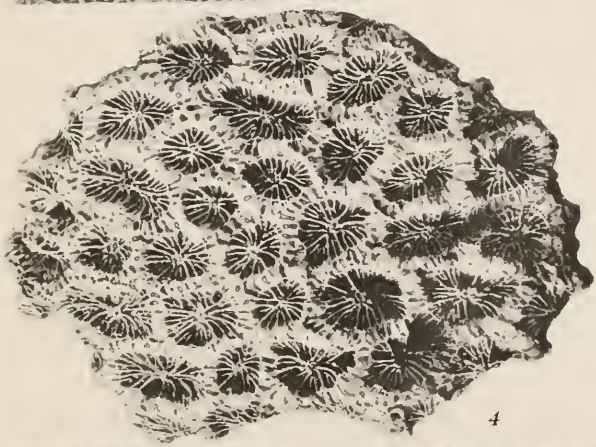

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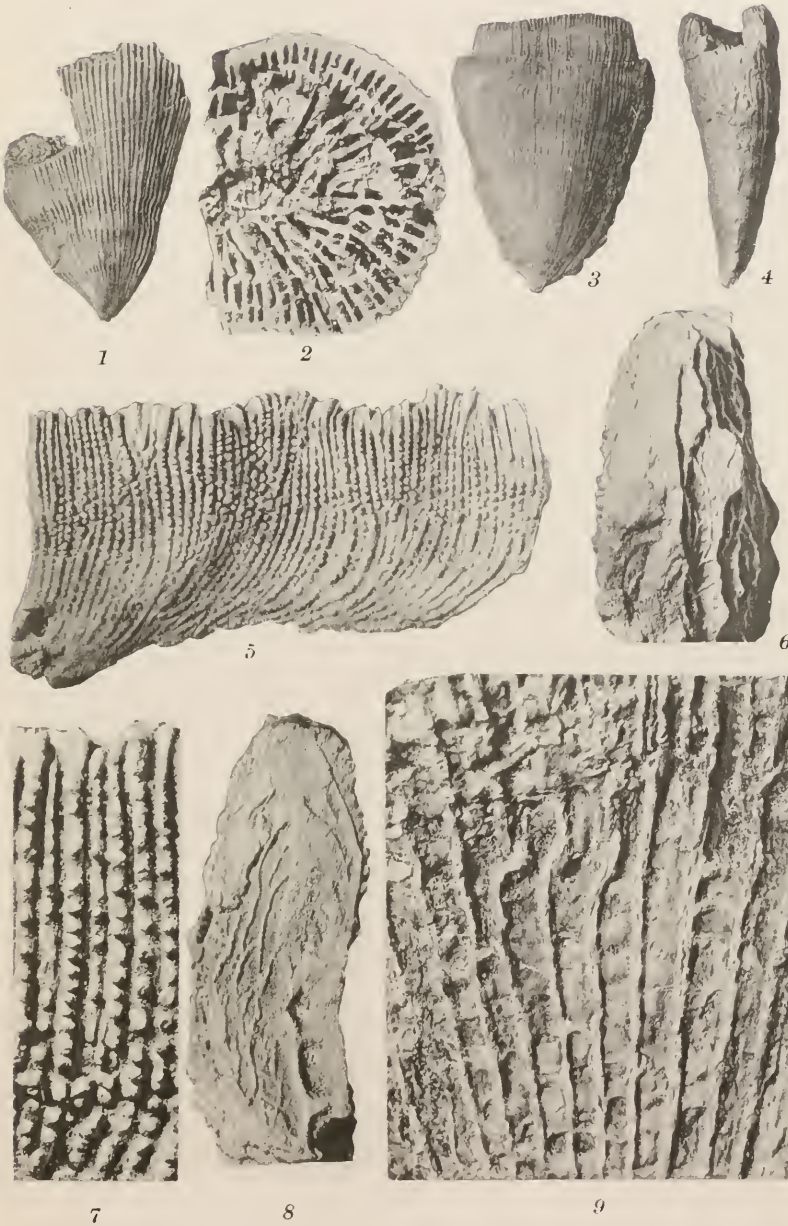
PLATE 3.

PLATE 3.

Fig. 1.— *Asterosmilia duncani* Vaughan. Corallum. Natural size.
Fig. 2.— Same, cross section of half of corallum to show transverse outline and dissepiments. × 2.
Fig. 3, 4.— *Asterosmilia compressa* Vaughan.
Fig. 5.— *Thysanus crassicostatus* Vaughan. Type. Side view. Natural size.
Fig. 6.— Same, longitudinal section. × 2.
Fig. 7.— Same, costae. × 3.
Fig. 8.— Same, longitudinal section. × 2.
Fig. 9.— *Antillia dominicensis* Vaughan. View of costal ends of septa and intervening mural dissepiments. × 3. (See also Plate **4**, fig. 1, 2).



1 2 3 4 5 6 7 8 9

PLATE 4.

PLATE 4.

Antillia dominicensis Vaughan. Type.

(See also Plate 3, fig. 9).

Fig. 1.— Side view. Natural size.
Fig. 2.— Calice. Natural size.

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Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LXVII. No. 9.

PSAMMOCHARIDAE FROM PANAMA.

By Nathan Banks.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

November, 1925.

3. Pseudagenia anconis, sp. nov.

Types.— M. C. Z. 15,338. Ancon. 3–9 August, 1924.

♀ Black; antennae beyond the basal third or half more or less reddish, especially below; first leg red on apical third of femur, all tibia, and base of tarsus; mid leg red on apical half of femur, nearly all of tibia; hind leg red on femur and basal part of tibia; clypeus, lower face, lower thorax, coxae, part of propodeum, and hind borders of several abdominal segments silvery. Wings hyaline, apex darker, stigma black. Clypeus two and a half times as broad as long, truncate in front; antennae slender, third joint much longer than the fourth; vertex nearly as wide as clypeal base; posterior ocelli only a little farther from the eyes than from each other; pronotum angulate behind; propodeum with long white hair; apex of abdomen with rather short hair, much short hair on venter; all coxae hairy; hind tibia with many small scattered spines, long spur not quite one half of basitarsus. Second cubital cell nearly twice as long as high, narrowed above, third much larger, twice as long as high, also narrowed above; first recurrent vein at middle of cell, second straight and ends at basal third of cell; basals disjointed; in hind wings the anal ends much before the cubital.

Length 9.5 mm.

4. Pseudagenia iolanthe, sp. nov.

Type.— M. C. Z. 15,339. Barro Colorado. 20 June, 1924.

♀ Head and abdomen black, thorax bluish green, iridescent; legs, except coxae, trochanters, and apical tarsal joints pale reddish yellow, hind tibiae more brownish; antennae brown, basal joint pale beneath; wings hyaline, stigma black; clypeus, lower face, lower thorax, mid stripe on propodeum densely white-haired, dorsum of thorax finely white pubescent, propodeum with long white hair above; tips of the abdominal segments more or less sericeous. Clypeus two and one fourth times as broad as long, broadly rounded below; third joint of antennae scarcely longer than the fourth, second plus third not equal vertex width, latter fully equals clypeal base; posterior ocelli much closer to each other than to the eyes; pronotum arcuate behind; propodeum rather short; hind tibiae with few very minute spines above, long spur fully one half of basitarsus. Second cubital one and one half times as long as broad, third much larger, twice as long as broad, narrowed above; first recurrent near middle, second faintly curved and much before middle of cell; basals nearly interstitial; in hind wings anal ends before cubital.

Length 7 mm.

5. Ageniella obscura, sp. nov.

Type.— M. C. Z. 15,340. Panama: Bella Vista. 6 July, 1924.

♀ Dull black, faintly sericeous; wings slightly fumose, almost hyaline, stigma dark. Clypeus about two and one half times as broad as long, anterior margin convex, and with a distinct median tooth; posterior ocelli much closer to each other than to eyes; third joint of antenna three fourths as long as vertex width, fourth hardly two thirds of third; hind margin of pronotum concave; propodeum short, sloping; abdomen rather short, apical segment much tapering, no long hairs near tip nor on venter; long spur of the hind tibia not reaching to middle of basitarsus. Second cubital cell plainly longer than high, each end rounded, third about one and one half times as long as high, much narrowed above, upper side no longer than lower side of second cubital cell; first and second recurrent before middle of cells, second faintly sinuate, basal veins not interstitial, in hind wings the anal vein ends much before the cubital.

Length 6 mm.

6. Ageniella nigribasis, sp. nov.

Type.— M. C. Z. 15,341. Barro Colorado. 13 July, 1924.

♀ Yellowish; head mostly dull black, but the lower face, clypeus, and antennae yellowish; legs yellowish, base of all coxae with a black spot; abdomen with first segment mostly black, the third and apical part of second also black; wings pale yellowish, with two black bands, one before, other beyond the middle, both very broad; body clothed with short, pale pubescence. Head densely and rather coarsely punctate; antennae close to clypeus, the third joint shorter than the fourth; clypeus short, rounded below; ocelli in a low triangle, posterior ones much closer to eyes than to each other; hind margin of pronotum strongly arcuate; propodeum but little convex; abdomen not much narrowed at base, short hairs at tip, longer hair on venter; hind tibia with few minute spines, long spur equal to one half of basitarsus; second cubital cell no longer than high, third nearly twice as long below, but little narrowed above, both recurrent veins received much before the middle of cells; basal veins disjointed.

Length 4.8 mm.

7. Ageniella rufothorax, sp. nov.

Types.— M. C. Z. 15,342. Barro Colorado. 20 July, 1 August, 1924.

Bluish black; entire upper and most of pleural surface of thorax reddish; face, coxae, and lower thorax clothed with silvery pubescence. Antennae black on basal half, about four joints pale yellowish, but apical one or two

joints dark, in male the last dorsal segment and tibial spurs are white. Clypeus broad, more than three times broader than long, the margin evenly and rather deeply concave; third joint of antennae a little longer than the fourth; posterior ocelli much closer to each other then to eyes, a long hair near each eye; pronotum rather angularly concave behind; apex of abdomen (♀) with many long black hairs, not in ♂; hind tibia with few minute spines, long spur hardly one half of the basitarsus. Wings hyaline, apex faintly dark, a black band over basal veins reaching across, another from stigma, not reaching across. Stigma dark; second cubital cell scarcely longer than high, trapezoidal, third more than twice as long as high, much narrowed above; first recurrent vein beyond middle, second recurrent much before middle of cells; second recurrent bent in middle; basal veins interstitial; in hind wings anal interstitial with cubital.

Length 11 mm.

8. Ageniella isolata, sp. nov.

Types.— M. C. Z. 15,343. Barro Colorado. 13, 20 July, 1924.

♀ Black; abdomen red; clypeus, mandibles, and much of antennae reddish; wings bifasciate; face, coxae, lower thorax, base and apex of propodeum with very fine silvery pubescence. Clypeus very broad, more than three times as broad as long, from above the edge is faintly convex, nearly straight in middle, from below the middle is weakly concave. Antennae with basal joint and one or two beyond yellowish, or reddish, then two or three brown, then three or four pale, and apical two brown, third joint only a little longer than fourth. Posterior ocelli only a little closer to each other than to eyes, a long hair each side near eye; pronotum almost angulate behind. Abdomen with short, yellow hair near tip, hind tibiae very faintly spinulate, the long spur not one half of basitarsus. Wings hyaline, apex faintly dark, a dark band over basal veins reaching hind margin, another from apex of stigma, not quite across; stigma yellowish. Second cubital a little longer than high, third twice as long as high, much narrowed above, first recurrent vein ends near middle, second recurrent near basal third of cells, the second only slightly curved; basal veins almost interstitial; in hind wing the anal vein ends before the cubital.

Length 6.5 mm.

Priocnemis.

1. Wings fulvous 2
   Wings more or less hyaline 3
2. Wings bifasciate with dark ..... *barbcuri.*
   Wings not banded ..... *fairchildi.*
3. Body spotted with yellow ..... *neotropicalis.*
   Head and thorax not spotted 4

4. Abdomen reddish, wings unmarked 5
   Abdomen black, wings marked 6
5. Third cubital higher than long, shorter than the second ..... *wheeleri.*
   Third cubital longer than high, longer than the second ..... *parkeri.*
6. Mid and hind femora reddish ..... *doddsi.*
   Femora black 7
7. Abdomen with pale band ..... *molinoi.*
   Abdomen all black ..... *zeteki.*

9. Priocnemis neotropicalis Cameron.

Two females, Ft. Davis, Panama, 5 July, 1924.

10. Priocnemis barbouri, sp. nov.

Type.— M. C. Z. 15,344. Panama (Thomas Barbour).

♀ Black; lower angles of pronotum pale; two spots of golden pubescence on the pleura, one each side on metathorax, two small at base of propodeum, and a large one each side near tip of propodeum; second and third segments of abdomen with a spot each side, and the apex above with rather paler pubescence; clypeus and coxae scarcely sericeous. Wings bright yellowish, apical margin narrowly dark, a broad black band over basals and another behind stigma, stigma yellowish. Clypeus short and broad, more than three times as broad as long, edge slightly convex and angled in the middle; lip projecting; antennae short and situate close to clypeal margin, third joint very long, much longer than fourth, and as long as vertex width, which latter is shorter than clypeal base; ocelli large, posterior ocelli about as near eyes as to each other; pronotum rather long, angulate behind; propodeum coarsely striate behind; abdomen elongate, some moderately long hair at tip, venter with few short hairs. Hind tibiae angled, hardly serrate, with rows of spines above and some below, long spur about one half of basitarsus, no hair on anterior coxae. Second cubital cell fully one and one half times as long as high, third nearly twice as long as high, narrowed above, the outer vein being angled; first recurrent near end of cell, second much curved, and before middle of cell; basals scarcely disjointed; in the hind wings anal ends before the cubital.

Length 17 mm.

Wing practically as in figure of *Pompilus chiriquensis* Cameron, but the position of posterior ocelli, and location of spots of pubescence is different.

11. Priocnemis fairchildi, sp. nov.

Type.— M. C. Z. 15,345. Barro Colorado. 26 July, 1924.

♀ Black, in some lights slightly violaceous, wings fulvous, apex scarcely darker, basal three and apical two joints of antennae black, rest fulvous. Clypeus hardly twice as broad as long, the lateral angles extended under the eyes, anterior edge truncate; antennae situate hardly one half of clypeal length above clypeus, third joint plainly longer than fourth, but second plus third scarcely equal vertex width, latter but little less than clypeal base; ocelli small, close together, posterior ocelli much nearer to each other than to eyes; clypeus and vertex with some long hair; pronotum short, emarginate behind, hairy above, as also rest of thorax, propodeum rather short, faintly striate in middle of sides, hairy above; abdomen but little depressed, with much short black hair on venter; hind tibia angled, not serrate, but with rows of short spines, long spur hardly one third of basitarsus, front coxae densely hairy in front. Second cubital cell hardly one and one half times as long as high, third nearly twice as long as second, much narrowed above; first recurrent vein ends beyond middle of cell, second recurrent slightly curved and ends much before middle of cell; basals slightly disjointed; in hind wings the anal ends a trifle beyond the cubital.

Length 19 mm.

12. Priocnemis wheeleri, sp. nov.

Type.— M. C. Z. 15,346. Barro Colorado. 23 July, 1924.

♀ Blue black; abdomen reddish, apex and venter rather more yellowish; clypeus, face, lower thorax, and coxae finely sericeous; vertex with two hairs each side near eye, otherwise smooth; propodeum with a few fine pale hairs above; tip of abdomen with short yellowish hair, venter with few hairs; clypeus large, about two and one half times as broad as long, edge strongly convex, polished, and with a low median projection, lateral angles extended under the eyes. Antennae less than one half of clypeal length above clypeus, third joint plainly longer than fourth, second plus third hardly equal vertex, latter a little shorter than clypeal base; posterior ocelli plainly nearer to each other than to eyes; pronotum angulate behind; propodeum low, faintly striate on sides, a broad median depression, broader behind. Abdomen slightly depressed; hind tibiae angled, not serrate, but with two rows of spines, long spur scarcely one half of basitarsus, mid tibia more distinctly serrate, front coxae almost bare. Second cubital cell fully three times as long as broad, base very oblique, third not as long, but much higher, outer edge very oblique; first recurrent at basal fifth of cell, second nearly straight and a little before middle of cell, basals scarcely disjointed; in hind wing anal is interstitial with the cubital. Wings faintly smoky, radial and second cubital cells more fumose.

Length 10.5 mm.

13. Priocnemis doddsi, sp. nov.

Type.— M. C. Z. 15,347. Panama: Red Tank. 1 July, 1924.

♀ Black; with few long hairs; clypeus, lower face, legs, sides of thorax, and much of propodeum silvery; mid and hind femora, spot below on hind tibia, and the front tibia beneath are reddish, spurs pale; wings hyaline, clouded over basal veins, and four clouds in radial, second and third cubitals, and in second discoidal cells, tending to form a band, stigma black. Clypeus three times as broad as long, punctured below, edge concave; antennae situate almost to clypeal margin, third joint very long, much longer than fourth, about equal to vertex width, latter much less than clypeal base, posterior ocelli as close to eyes as to each other, pronotum slightly emarginate behind; propodeum without long hair; abdomen polished, with some long hair near tip, sparse on venter; hind tibia slightly serrate, long spur one half of basitarsus; second cubital cell longer than high, third but little longer, narrowed above, and on radial cell shorter than second cubital, first recurrent at middle, second curved in middle and before middle of cell; basals interstitial; in hind wing anal almost interstitial with cubital.

Length 6 mm.

14. Priocnemis parkeri, sp. nov.

Type.— M. C. Z. 15,348. Panama: Bella Vista. 6 July, 1924.

♀ Black; abdomen reddish, last segment dark brown; clypeus and lower face silvery, coxae and propodeum less so; head, pronotum, and propodeum with fine short pale hair, tip of the abdomen more densely hairy, venter with short pale hair; wings uniform smoky, stigma black; spurs pale. Clypeus about three times as broad as long, edge slightly convex, antennae nearly one half of clypeal length above clypeus, third joint little if any longer than fourth; vertex fully equal clypeal base; ocelli small, posterior ones much closer to each other than to eyes; pronotum behind angulate; propodeum but little convex; hind tibia strongly serrately spined, long spur one half of basitarsus; second cubital about one and one half times longer than broad, third but little longer, narrowed above, first recurrent before middle of cell, second recurrent slightly curved and at middle of cell; basals disjointed; in hind wings the anal ends much before the cubital.

Length 5.5 mm.

15. Priocnemis molinoi, sp. nov.

Types.— M. C. Z. 15,349. Barro Colorado. 1♂, 23 July, 1924.

♀ Black; slightly sericeous, with very few pale hairs, palpi pale, apical segment densely clothed with white hair, and a broad whitish band across base of second abdominal segment above; legs rather brownish, mandibles partly

pale. Clypeus two and one half times as broad as long, edge nearly straight across; antennae nearly one half of clypeal length above clypeus, third joint long, much longer than the fourth, second plus third equal vertex width, latter little less than clypeal base; posterior ocelli much nearer each other than to eyes, a long hair each side near eye; pronotum roundedly emarginate behind; propodeum rather flat, sericeous, but without long hair; abdomen depressed, venter with very short hair; hind tibia with few short spines, but in one row, otherwise not serrate, long spur fully one half of basitarsus. Wings hyaline, a black band over basal veins, a much broader one over radial cell and across, beyond which the wing is white, stigma black; second cubital cell one and one fourth longer than high, third about twice as long as high, much narrowed above; first recurrent before middle of cell, second slightly curved and beyond middle of cell, basals interstitial; lower section of basal vein much curved; in hind wings anal ends before cubital.

Length 6.5 mm.

16. Priocnemis zeteki, sp. nov.

Type.— M. C. Z. 15,350. Barro Colorado. 25 July, 1924.

♀ Black, clothed with white hair, that on clypeus, coxae, lower thorax, and apex of propodeum dense, and silvery; wings bifasciate, one over the basal veins, other behind stigma. Clypeus two and one fourth times as broad as long, edge strongly evenly convex; antennae about one third of clypeal length above clypeus, the third joint a little longer than the fourth; vertex width less than clypeal base, posterior ocelli only a little nearer to each other than to eyes; pronotum angulately emarginate behind; propodeum with long hair, except at base; abdomen polished, apex with many fine, short hairs, venter with moderately short hair; hind tibiae not very strongly serrate, long spur scarcely one half of basitarsus. Stigma black; second cubital cell about twice as long as high, third still longer, much narrowed above; first recurrent vein beyond middle of cell, second recurrent nearly straight, and ends before middle of cell; basal veins disjointed; in hind wing the anal ends before cubital.

Length 9 mm.

The various species of Priocnemis here treated can be arranged in several sections which may rank as subgenera, and are tabulated (in connection with some United States species) as follows.

1. Antennae situate close to clypeal suture, pronotum rather large, propodeum striate 2
   Antennae plainly separated from the clypeal suture, pronotum smaller, propodeum not striate or barely so 3
2. Eyes not reaching to lower edge of clypeus; basal veins much disjointed (*fortis, comparatus, nigripes*) ..... *Dinocnemis.*
   Eyes extend to lower edge of clypeus, basals interstitial, first recurrent ends near end of second cubital, claws cleft (*barbouri*) ..... *Balboa.*

3. Clypeus very large, basolateral angles extended under the eyes; antennae rather high up, basals a little disjointed (*wheeleri*, *fairchildi*). *Priocnemella.*

Basolateral angles of clypeus not extended under the eyes.....4

4. Clypeus large, elevated, as long as basal joint of antenna, basitarsus of front legs spined all over (*neotropicalis*, *nuperus*).....*Priocnessus.*

Clypeus smaller, shorter than basal joint of antenna, front basitarsus not spined above.....5

5. Basals interstitial or nearly so (*doddsi*, *molinoi*).....*Calicurgus.*

Basals widely disjointed (*zeteki*, *parkeri*).....*Priocnemis.*

17. Pepsis charon Mocsáry.

One male, Barro Colorado, 31 July, 1924.

18. Pepsis azteca Cameron.

One female, Barro Colorado, 29 July, 1924.

19. Notocyphus chiriquensis Cameron.

One male, Ft. Davis, Panama, 5 July, 1924.

20. Planiceps innotatus, sp. nov.

Type.— M. C. Z. 15,351. Barro Colorado. 19 July, 1924.

♀ Dull black, abdomen more polished, clothed with fine appressed gray pubescence. Wings black, pale on basal third, and again near the middle; hind wings less fumose. Face narrowed below, and somewhat above; clypeus very short, nearly five times as broad as long; antennae short, third joint shorter than either the fourth or first; posterior ocelli close to ridge of vertex, about as close to eyes as to each other; pronotum slightly arcuate behind; propodeum short, not hairy above; abdomen not longer than thorax, few hairs near tip. Legs short, front femora and tibiae compressed, tarsus without comb; mid and hind tibia with prominent spines, long spur nearly two thirds of basitarsus. Second cubital cell scarcely longer below than high, upper side hardly one half of lower; first recurrent much before middle of cell, second recurrent just beyond this cell; radial cell less than its length from tip of wing; basals disjointed.

Length 4 mm.

21. Batazonus marcidus Smith.

One female, Ancon, Panama, 4 August, 1924.

22. Batazonus flavopictus Smith.

Two females, Barro Colorado. 2 August, 1924. Ancon, Panama, 6 July, 1924.

23. Arachnophroctonus virulentus Smith.

One female, Barro Colorado, 19 July, 1924.

24. Notiochares philadelphicus Lepeletier.

One female, Frijoles, Panama, 10 July, 1924.

25. Pompiloides coruscus Smith.

Two females and a male, Bella Vista, Panama, 7 and 8 August, 1924. It may be that the Central American form is not the same as the type from Santo Domingo, but it is so treated by Cameron in the Biologia Centrali Americana.

Bulletin of the Museum of Comparative Zoölogy

AT HARVARD COLLEGE.

Vol. LXVII. No. 10.

NEW CEPHALOPODS FROM THE FAYETTEVILLE SHALE.

By Carey Croneis.

With Two Plates.

CAMBRIDGE, MASS., U. S. A.:

PRINTED FOR THE MUSEUM.

February, 1926.

No. 10.— *New Cephalopods from the Fayetteville Shale.*

By Carey Croneis.

The cephalopods described here constitute a portion of the palaeontologic collection from the Fayetteville formation made during the academic years 1923–1925, while the writer was a member of the Department of Geology of the University of Arkansas. The formation takes its name from the city of Fayetteville, the site of the University, in whose environs it is well exposed. The bulk of the collection is now the property of the University of Arkansas Museum, but the holotypes of the species described in this paper belong to the Museum of Comparative Zoölogy. The writer is indebted to Dr. Percy E. Raymond for numerous suggestions and criticisms in this study, to the University of Arkansas for its coöperation in making the collection, and to Mr. E. B. Dane for his assistance in the preparation of the plates.

Before describing the fossils themselves, it may be well to discuss briefly the formation in which they occur. The Fayetteville shale of Arkansas and Oklahoma is, in general, a black, fissile, carbonaceous shale usually overlain by the Pitkin limestone, which marks the top of the Mississippian in this region. It rests either disconformably upon the Boone limestone or conformably upon the Batesville sandstone, where the latter is present. Not infrequently the Pitkin has been removed entirely by pre-Pennsylvanian erosion, and in this case the Fayetteville is overlain by the Morrow series of early Pennsylvanian age. More rarely, as in northeastern Oklahoma, the Morrow also is wanting and the Fayetteville is succeeded by the Winslow formation, which is regarded as the local equivalent of the Pottsville.

Although black shales constitute the bulk of the formation, there is, near the top, a prominent sandstone member, known as the Wedington, and which may be mapped over considerable areas in the central and western portions of the Fayetteville exposure. The shale above the Wedington reaches a maximum thickness of seventy feet, but usually it is much thinner and is often wanting. It is neither so dark nor so fissile as the shale beneath the sandstone, and some thin fossiliferous layers of limestone are found interbedded with it. The lower shale is black in color, but weathers to sticky red and yellow clays. Near its base it contains numerous concretions of clay ironstone or siderite which are usually extensively cut by calcite veins to make septaria.

These are often so numerous that they make up approximately continuous septarian layers. A thin limestone at the base of the formation is particularly rich in fossils, and it has yielded several new genera and species which have been described by G. H. Girty (Annals N. Y. acad. sci., 1910, **20**, no. 3, pt. 2). This limestone, which is quite widespread in the Fayetteville region, has not been seen east of the Eureka Springs quadrangle, but to the west it becomes more and more prominent until in Mayes County, Oklahoma, it reaches a thickness of 50–100 feet. Here Snider (Bull. 24, Okla. geol. surv., 1915, p. 27–35) has described it as the Mayes formation.

The Fayetteville has been observed as far north as Fairland, Oklahoma, sec. 15, T. 26 N., R. 29 E., whereas its southernmost exposure is four miles northeast of Gore in the same state in sec. 20, T. 13 N., R. 21 E. The easternmost outcrop of the formation known to the writer is in sec. 35, T. 12 N., R. 5 W., which is a few miles southeast of Batesville, Arkansas. Westward it extends to sec. 2, T. 17 N., R. 19 E., on the eastern bank of Neosho River in Oklahoma. Thus the formation outcrops over an area which in its extreme dimensions is approximately eighty miles north and south by some two hundred and twenty-five miles east and west. Its north-south exposure, however, is usually confined to a belt which is roughly coincident with the lower slopes of the northern face of the Boston Mountains.

In this area the Fayetteville is never wanting, but its thickness varies from as little as ten to about four hundred feet, with extremes of thickness often geographically close together. The formation will probably average close to one hundred feet in thickness, but the chances for error in such an approximation are high and must be considered. The variations in thickness are due to deposition on an irregular surface, whose unevenness was the result in part of erosion, and in part due to structural features.

The fauna of the Fayetteville is abundant and diversified. It has attracted the attention of a number of writers, but it has never been worked out in detail. Previous workers, however, have generally agreed upon the Chester age of the sediments, which at different times have been correlated with the Kaskaskia (Ulrich, Prof. paper 24, U. S. G. S., 1904, p. 24) and Birdsville (Ulrich, Bull. Geol. soc. Amer., 1911, **22**, pl. 29) formations of Illinois, and with the Caney shale of Oklahoma (Girty, Bull. 377, U. S. G. S., 1909, p. 10). Weller, according to a verbal communication to Snider (loc. cit., p. 39), believes that the Fayetteville is probably to be correlated with the Okaw formation of the Chester section in the Mississippi Valley. Girty (Bull. 593,

U. S. G. S., 1915, p. 25), however, although recognizing the general equivalency of these beds with some of the typical Chester formations, is inclined to the view that the upper Mississippian of northern Arkansas belongs to a different faunal province than the northern Chester, and that it is impossible to combine the two into a standard time scale. The present writer defers expressing his opinion on the matter until the faunal studies are completed.

Annulated, orthoconic cephalopods are common in a sandy limestone which appears in the stratigraphic position of the top of the Wedington. Coiled forms are also known from this horizon, which is best developed in the vicinity of Fayetteville, and where the Wedington is apparently thinner and more calcareous than usual. The cephalopods described below, however, are from the lower shale of the formation, a part of the Fayetteville which the older geologists regarded as being totally devoid of fossils. More recent writers have recognized the presence of a poorly-preserved pelecypod fauna, and diligent search has revealed several localities where at least average molluscan fossils may be obtained.

ACTINOCERATIDAE Saemann.

Rayonnoceras, gen. nov.

Genotype: *Rayonnoceras solidiforme*, sp. nov.

The generic term Rayonnoceras is here proposed for a group of cyrtochoanitic cephalopods related to Actinoceras and others of the Actinoceratidae, to which family it obviously belongs, but which differs from existing genera in a number of particulars.

Generic description.— Orthoconic Actinoceratidae with camerae completely filled by a uniform organic deposit secreted by the rayonnettes of the endosiphuncle, which terminate at the outer shell of the animal rather than at the outer margin of the siphuncle. Siphuncle large, solid throughout, and strongly corrugated longitudinally, except on the ventral side.

Rayonnoceras solidiforme, sp. nov.

Plate **1**, fig. 1–4, 6; Plate **2**, fig. 4, 5.

Specific description.— The holotype has a length of 564 mm., a greatest diameter of 145 mm., and a diameter of 45 mm. at the posterior end of the incomplete specimen. The greatest siphuncular diameter

increases from 15 mm. at the posterior end to 43 mm. at the anterior extremity. These figures indicate that the siphuncle increases in diameter nearly, but not quite, as rapidly as the conch itself. The rate of expansion of the shell is approximately 1 mm. in diameter for 6 mm. in length, indicating an apical angle of about nine degrees.

The siphuncle, which is conspicuously ventrad in position, is composed of nummuli whose greatest diameter is approximately twice the length, the largest nummulus being 43 mm. in diameter and 21 mm. in length. The plane of separation between successive nummuli makes an angle of eighty-two degrees with the longitudinal axis of the siphuncle, and in general the diameter at the septal necks is one half the greatest nummular diameter. The nummuli are strongly corrugated longitudinally, except on the ventral side, four to five corrugations occurring in the space of 1 cm.

The septa show a concavity which is approximately one and a half times the length of the adjacent nummulus. The false septa, which join the nummuli a little above their middle (on the dorsal side) reach the outer shell practically in conjunction with the next anterior, true septum, hence their concavity is greater, being equal to the length of two nummuli. There are seven septa per diameter below the point of diametral measurement, or six septa above, which is to say that, on the average, five camerae occur per diameter. The camerae are all filled with a uniform organic deposit (p. 345).

The shell is marked by fine girdling striae which are nowhere continuous enough to determine their course about the conch. The sutures show broad, gentle, but distinct lateral lobes, but their nature on the ventral side is obscured by the crushed condition of the shell.

The siphuncle and its fillings.— Each nummulus of the siphuncle is divided externally into an anterior and a posterior portion by a line which circles it approximately in the plane of greatest diameter, but which is distinctly orad of the true median position on the dorsal side. This line represents the contact of the rayonnettes of the endosiphuncle with the siphuncular wall. One of the nummuli was broken in two along this plane, which is seen to be nearly smooth on the fractured surface, although faintly grooved in a radial fashion. This fact suggests that the double membrane making up the verticillations about the endosiphuncle approached a two-walled disk in structure, and was only prevented from becoming one in effect because the membranes were in contact in some places. This idea is also substantiated by the fact that the line which roughly halves the nummulus is, in the unbroken example, seen to be alternately single and then double. In

the nummuli which have weathered free from the specimen, there may be seen also a longitudinal line crossing the vertical line mentioned above approximately at right angles. It appears on both the ventral and dorsal sides of the nummuli, and in section is seen to divide the siphuncle into halves.

The septal necks, which are very short, are adnate to the posterior portion of the nummuli. The involution of the wall of the siphuncle, which appears at the septal necks, is narrow longitudinally, yet its depth is about one fourth the greatest diameter of the nummulus. The inner portions of the depression are directed slightly apically. The imaginary plane of separation between successive nummuli is so inclined as to give the appearance of alternation of annulations in the longitudinal section, the ventral sides of the nummuli being anteriorly in advance of the dorsal. The eccentricity of the siphuncle mentioned under the specific description, although real, is accentuated by the crushed and flattened condition of what appears to be the ventral side of the shell.

In Rayonnoceras, as in Huronia and Actinoceras, the interior of the siphuncle was filled with calcareous organic deposits, which began to form around the inner margins of the septal necks. With the formation of additional layers the deposits became reniform or lunette-like in longitudinal section, the concave portion being the point of contact with the septa. As the lunettes of successive septal necks grew they tended to meet along a line which is anterior to the median plane of the nummulus on the dorsal side, but which is almost exactly in the plane on the ventral side of the siphuncle (Foerste, Contrib. Mus. geol. Univ. Mich., 1924, **2**, no. 3, p. 43). Actually the lunettes are separated by verticillated rayonnettes which have their axis in the endosiphuncle, and which divide the nummuli approximately in halves. The double membrane previously mentioned was, no doubt, the organ secreting the calcareous deposits. The triangular spaces between the outer margins of adjacent lunettes and the inner margin of the annulation are also filled with organic deposits, as is the space between the four lunettes in the center of each nummulus. These deposits, although not exactly amorphous, do not show the uniformity of structure exhibited by the lunettes.

The fillings of the camerae.— In the longitudinal section each camera has a doubly septate appearance, being divided into a posterior and an anterior portion by a pseudoseptum which extends from the median plane of the nummulus to the shell of the animal. These false septa are continuations of the double membranes of the rayonnettes. The

pseudosepta are ordinarily represented by two closely-spaced lines with small triangular projections extending out into the camera on either side; but in some cases the membranes have been pushed together so that but one wavy line may be seen. Apparently, during life, many thin membranes extended out from each pseudoseptum to the true septa on either side, but were not developed in the area adjacent to the siphuncle; or, at least, they were much less prominent there.

The deposition of stereoplasm, or calcareous, organic material, in each camera began simultaneously on the inner sides of the two true septa limiting the chamber. On each a thin layer of uniform thickness was deposited, which extended from the shell of the animal along the septum two thirds of the distance to the siphuncle. The second layer was deposited upon the first, but overlapped it on the end toward the siphuncle in such a way as to become normal to the septum. Every successive layer was deposited in the same manner, so that each on its inner margin bent over the former to touch the septum; and, since the camerae become more constricted toward the shell, each layer was diagonally truncated at its outer margin by the pseudoseptum. Thus, in each camera, deposition took place on both sides of a "V"-shaped opening whose apex was on the pseudoseptum and which opened out toward the nummulus. As more layers of stereoplasm developed, their inner margins moved closer to the septal necks and the apex of the open space migrated toward the siphuncle. Thus the double membrane was finally enclosed in solid material everywhere, but in that limited area close to the nummulus, where the deposits do not show the uniformity of structure which they exhibit farther out toward the shell.

The calcareous material adjacent to the siphuncle is darker than the other deposits of the camerae, and it was evidently deposited later. It is possible that it was formed after the death of the animal by the infiltration of the fine muds in which the shell was buried. On the other hand, there is evidence to support the idea that it also was secreted by the animal. A close examination shows that the deposit is not entirely devoid of organic structure; and that in several camerae double membranes extend on either side of the pseudoseptum out to the true septa, thus crossing the dark material in a longitudinal direction.

Due to the crushed condition of the shell on the ventral side of the siphuncle, the deposits here are not regular, but are composed of numerous fragments of shell-like material intimately cemented together in a

darker matrix. In the longitudinal section the septa are seen to be crushed inward in an anterior direction, and while they are broken and faulted, they ordinarily may be traced for some distance. The light shell-like material so prominent in this area is seen to have identically the same structure as the darker stereoplasm dorsad of the siphuncle, and was deposited on the septa in exactly the same fashion. In some cases a septum and its layers of stereoplasm have fractured as a unit, but more often in the crushing the deposits have become separated from the septa.

The deposition of stereoplasm was at first uniform on all sides of the siphuncle. With the secretion of each additional layer, however, the ventral side was called upon to support more and more weight. In response the animal secreted the ventral stereoplasmic layers more thickly and rapidly, which may account for their lighter color. In spite of this reënforcement of the septa, the shell was crushed while the camerae were still relatively open. After this flattening of the ventral side of the animal, deposition in the uncrushed portions of the camerae went on to completion as described above. The material deposited in the ventral area subsequent to the crushing was no different from the deposit secreted in the camerae adjacent to the dorsal side of the siphuncle. Although the outer shell of the animal is very much crumpled in the flattened zone, it is nowhere seen to be fractured. This is perhaps the more remarkable because of the fact that the shell is extremely thin, almost always being under 2 mm. in thickness.

Comparison with other genera and species.— So far as the writer is aware, the genus Rayonnoceras is represented by the largest specimens of orthoconic Carboniferous cephalopods known from North America. The holotype of *R. solidiforme* (see also the description of the holotype of *R. fayettevillensis*) has a known length of 564 mm., and, if the apical angle remains constant, a reconstructed posterior length of 225 mm. The fossil is still septate at the anterior known portion, so that *at least* the length of the body-chamber must be added. If we conservatively estimate the length of the living chamber as being equal to one third the length of the septate portion of the shell, the reconstructed conch has a length of three feet six inches.

The only other Carboniferous cephalopod comparable to the Fayetteville specimens in size is *Actinoceras giganteum* (Sowerby) from the red limestone of Castle Espie, County Down, Ireland, which McCoy (Carboniferous fossils of Ireland, 1844, p. 11) describes as sometimes attaining a length of four feet. *A. giganteum* is the same as *Orthoceras gigantea* described by Sowerby (Min. Conch., 1818, p. 81)

and *A. simmsii* figured by Stokes from the same horizon. Stokes (Trans. Geol. soc. London, 1837, p. 708), however, gives the length of *A. simmsii* as being only two feet.

Actinoceras pyramidatum McCoy, also from the Carboniferous of Ireland, has some points of similarity with *R. solidiforme*, but the rate of enlargement is greater, the endosiphuncle is larger, and the camerae are not solid, though they are filled to some extent by deposits. In addition, the rayonnettes number but three or four rather than being practically continuous, and the corrugations of the siphuncle are not interrupted on the ventral side. In *A. vaughanianum* Girty (Bull. 377, U. S. G. S., p. 48) we might expect to find a close resemblance to *R. solidiforme* since it is found at approximately the same horizon (the Caney shale of Oklahoma) and does have some superficial features in common with the Fayetteville form, including size. But here again the camerae of *A. vaughanianum* are only partially filled by organic deposits, the apical angle is less than in *R. solidiforme*, the sutures are straighter, the shell not only is thicker but lacks striae, and the concavity of the septa is less.

Points of similarity between *R. solidiforme* and many of the Actinoceroids might be cited, but the differences always resolve themselves into dissimilarities in the deposits of the camerae and in the rayonnettes of the endosiphuncle. Grabau (Palaeontologica Sinica, 1922, p. 73, 74), however, has described a number of Chinese Actinoceroids from the Machiakou limestone of Ordovician age (Black River), whose septal thickening may perhaps be explained as analogous to the fillings of the camerae in Rayonnoceras. Under the generic description of the group, he says: —

"In practically all of the specimens of Actinoceras from the Machiakou limestone, a striking thickening of the septa by stereoplasm or organic deposits of carbonate of lime has taken place, so that the camerae are more or less completely filled by this calcareous deposit. Complete filling is rare, but has been observed in some cases, while in others the thickening has proceeded only far enough to fill about one half of the camera. The thickening is most generally produced by addition of lime to the upper surface of the septum, but in other cases it appears to be added to the under side as well. It is however possible that this appearance is deceptive, and due to the irregularity of the septum. * * * That this lime-deposit is of organic origin, *i. e.* deposited by the animal which occupied the shell, is beyond question, for only by such an origin can the uniformity of the deposit be explained. That it was formed on successive floors of the living-chamber, *i.e.* that each deposit was formed before the next covering septum was built, seems to me also evident, for there is absolutely no indication that the camerae were in subsequent communication with the animal, the small tubuli of the siphuncle notwithstanding. . . ."

and later (p. 78), under the specific description of *A. richthofeni* Frech, he says: —

"In some cases the stereoplasm is included between the septum and a pseudoseptum next in front. * * * Again there may be a slight deposit of stereoplasm both on the upper and under sides of the septum, but this is generally irregular, especially on the under side, as if the septum had been broken. Thickening by stereoplasm on both sides of the septa is indicated in Frech's figure of the type, but I have not seen any specimen in which the thickening is as regular as is shown on the right side of his figure. A fragment which I refer to this species * * * has the camerae nearly filled with stereoplasm, the septa appearing out of position, ending apparently against the nummuli. This would give the appearance of Frech's figure, if we assume that the septa are pseudoseptа, and that true septa occur in the midst of the stereoplasm deposit. Of this there is however no indication. In fact, the septa are strongly bent backwards, so as to rest for a space against the upper or frontal surface of the next preceding nummulus. If a deposit of stereoplasm exists on the under side of the septum it could hardly be explained otherwise, than by assuming its formation to have taken place after the formation of the septum, in which case there must have remained some organic connection between the camera and the animal."

That there was an organic connection between the camerae and the animal in *Rayonnoceras solidiforme* is clear; and if we assume that such was also the case in *Actinoceras suanpanoides*, *A. richthofeni*, *A. tani*, and especially in *A. coulingi*, the deposits of stereoplasm in these forms may be explained more easily and rationally. The newly established genus, Stereoplasmoceras, also from the Machiakou limestone of northeastern China, and from which Grabau suggests that Actinoceras may have been derived, is, as its name implies, characterized by organic deposits in the camerae. In a number of its species stereoplasmic thickening on the under side of the septa has gone on to an embarrassing degree, if we attempt to explain the formation other than by deposition by membranes in the camerae.

In 1861, Owen (Palaeontology, p. 102) suggested that the tubes, or foramina (rayonnettes) of the Actinoceratidae may have served for the passage of blood-vessels to the living membrane of the septal chamber. This suggestion, certainly disregarded, and perhaps overlooked, is at last substantiated in Rayonnoceras. Since in this genus the animal maintained communication with its septal chambers, it is fair to presume that allied forms may have done likewise in greater or less degree; particularly when they exhibit septal thickening which cannot be explained satisfactorily otherwise.

Three remarkable preservations of the endosiphuncle and its rayon-

nettes in Niagaran Actinoceroids are introduced for comparison in Plate **2**, fig. 2, 3, and 6. They represent hitherto unfigured specimens from the Walcott collection in the M. C. Z. In these early forms the rayonnettes of each nummulus are few in number rather than being so continuous as to be disk-like, as they are in Rayonnoceras. These specimens show marked differences from one another in the method of diverticulation of the tubuli, and in Figure 3, the foramina are seen to extend through the siphuncular wall where that part of the animal has been preserved. That there were membranes in the camerae of all of these forms is probable, but by no means certain; but a lack of evidence for their presence must not be construed as proof of their absence.

Rayonnoceras solidiforme had the ability to re-cement fractures in its shell as evidenced by the mended portion of the conch shown (Plate **2**, fig. 4). This is a property which has long been recognized in other Nautiloids; but the explanation of the process of repair would be greatly simplified if we assumed that the animals maintained membranes in the camerae.

Locality and horizon:—Rayonnoceras solidiforme is represented by a single specimen from the N. $\frac{1}{2}$ of the NW. $\frac{1}{4}$ sec. 29, T. 15 N., R. 28 W. at Durham, Arkansas. Its exact stratigraphic position was fifteen feet above the top of the Boone limestone in the lower shale of the Fayetteville formation.

Rayonnoceras fayettevillensis, sp. nov.

Plate **1**, fig. 5; Plate **2**, fig. 1, 8.

Specific description.— The holotype has a length of 640 mm., of which the posterior 307 mm. is uncrushed. It has a greatest diameter of 82 mm. at the anterior end of the uncrushed portion, and a diameter of 28 mm. at the posterior end of the incomplete specimen. The ratio of expansion of the shell is about 1 mm. in diameter for 6 mm. in length, indicating an apical angle of nine degrees.

The rate of increase in the diameter of the siphuncle is slight, the apical angle being less than four degrees. *R. fayettevillensis* differs further from *R. solidiforme* in that the nummuli are not so flattened, the ratio of the greatest width to the length being as eleven to seven. In addition the concavity of both the true and false septa is less in this species, being equal to the length of one nummulus in the case of the true septa, and the equivalent of the length of one and a half nummuli

for the false septa. The imaginary plane of separation between successive nummuli makes an angle of eighty degrees with the longitudinal axis of the siphuncle. The endosiphuncle is more prominent than in *R. solidiforme*, but the deposits in the siphuncle are less regular, and the lunettes are not conspicuous.

The fillings of the camerae are also different from those in *R. solidiforme*, although the broken material on the ventral side of the siphuncle is arranged in somewhat the same fashion. The pseudosepta are definitely anterior of the median portion of the septal chambers, and the deposits exhibit no layers built up on the septa. Instead, the stereoplasm shows no definite structure except that it is marked by a series of ray-like projections, which extend out from the pseudoseptum in each camera. In all other respects *R. fayettevillensis* is essentially the same as *R. solidiforme*, and it is doubtful if the two could be distinguished one from the other in unsectioned specimens.

A small specimen found at the same locality as the holotype exhibits a very similar internal structure and is referred to this species in spite of the slightly cyrtoconic character of the shell in its early neanic stage.

Locality and horizon.— These specimens were found on Fly Creek, a tributary of the Barren Fork of Illinois River, Arkansas, in the NE. $\frac{1}{4}$ of the NE. $\frac{1}{4}$ sec. 29, T. 14 N., R. 32 W. Their exact stratigraphic position was thirty feet above the top of the Boone limestone, in the lower shale of the Fayetteville formation.

Rayonnoceras cadyi, sp. nov.

Plate 2, fig. 7.

Specific description.— The holotype is a badly crushed, incomplete specimen having a total length of 353 mm. The diameter at the anterior end is 105 mm. and 38 mm. at the posterior end. This would indicate an apical angle of about ten degrees, but this figure is too high owing to the fact that the flare due to flattening is greatest at the anterior end of the specimen.

The rate of enlargement of the siphuncle is very small, being but 1 mm. in diameter for 26 mm. in length. The deposits of the siphuncle are not so regular as in *R. solidiforme* but they are more uniform than in *R. fayettevillensis*. The lunettes are well developed, although they are not prominent in the longitudinal section. The endosiphuncle is large and its rayonnettes divide the nummuli distinctly above their median plane. The ratio of the width to the length of the nummuli is as thirteen to eight and the plane of their greatest diameter is orad of

the median plane. Thus they are in outline somewhat like the nummuli of Huronia, although the flare is not as prominent as is usual in that genus. The imaginary plane of separation of the nummuli is practically normal to the longitudinal axis of the siphuncle. The eccentricity of the siphuncle is slight.

Probably seven septa occur per diameter, but the crushed condition of the conch makes measurements uncertain. In section the septa are seen to extend straight from the siphuncle diagonally forward to the shell of the animal; they are everywhere roughly equidistant from one another, and from the pseudosepta. This feature also may be the result of the crushing of the conch, but the deposits of the camerae do not indicate that they have been disturbed. The deposits of stereoplasm are composed of uniform layers which extend straight from the pseudoseptum to the true septa and are normal to them throughout.

The sutures were plainly undulating, but the position of the lobes and saddles cannot be determined. The shell itself is unknown.

Locality and horizon.— This specimen was found at Durham, Arkansas, at the same locality and horizon which yielded the holotype of *R. solidiforme*.

EXPLANATION OF PLATES.

PLATE 1.

PLATE 1.

Fig. 1. *Rayonnoceras solidiforme* Croneis. The ventral side of two of the anterior nummuli of the holotype, a trifle over natural size. The figure shows the diminution of the corrugation on this side of the siphuncle, and the prominence of the two lines which mark the junction of the membranes with the siphuncular wall. M. C. Z. 2,326.

Fig. 2. *Rayonnoceras solidiforme* Croneis. Another portion of the holotype. A view of the surface obtained by breaking a nummulus into halves along the plane formed by the rayonnettes of the endosiphuncle. ($\times \frac{3}{4}$). M. C. Z. 2,327.

Fig. 3. *Rayonnoceras solidiforme* Croneis. The polished dorsal side of the two anterior nummuli shown in Figure 1. ($\times \frac{3}{4}$). M. C. Z. 2,326.

Fig. 4. *Rayonnoceras solidiforme* Croneis. One of the anterior nummuli of the holotype, natural size, showing the plane of junction with the next nummulus. M. C. Z. 2,328.

Fig. 5. *Rayonnoceras fayettevillensis* Croneis. A dorsal view of the holotype. ($\times \frac{1}{5}$). M. C. Z. 2,329.

Fig. 6. *Rayonnoceras solidiforme* Croneis. A polished longitudinal section of a portion of the holotype made in a dorsoventral direction. In this figure the section is oriented in the normal position of the animal during life. M. C. Z. 2,330.

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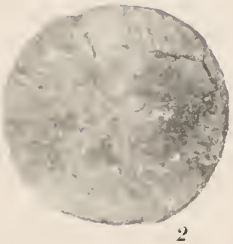

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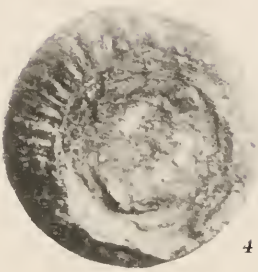

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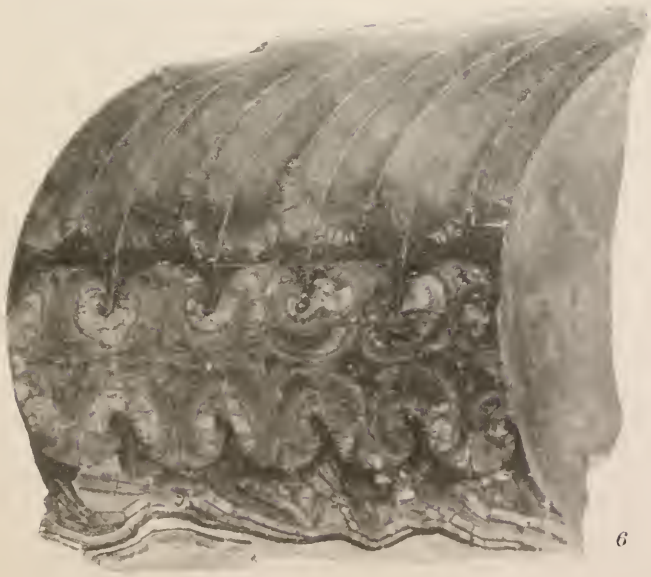

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PLATE 2.

PLATE 2.

Fig. 1. *Rayonnoceras fayettevillensis* Croneis. A polished section of a part of the neanic portion of the holotype. (× ¾). M. C. Z. 2,331.

Fig. 2. A portion of the endosiphuncle of an unidentified Niagaran Actinoceroid in the Walcott collection of the M. C. Z. (× ¾). M. C. Z. 2,332.

Fig. 3. Another endosiphuncle (Walcott Coll.), showing a different method of diverticulation of the rayonnettes. In this specimen a portion of the wall of the siphuncle is preserved and one of the rayonnettes is seen to extend through it. (× ¾). M. C. Z. 2,333.

Fig. 4. *Rayonnoceras solidiforme* Croneis. A portion of the holotype which has been fractured and re-cemented during the life of the animal. The broad lateral undulations of the sutures are also shown. (Natural size). M. C. Z. 2,334.

Fig. 5. *Rayonnoceras solidiforme* Croneis. Another portion of the specimen shown in Figure 4. A longitudinal section made across the crushed portion of the shell to show the character and position of the septa in this area. (Natural size). M. C. Z. 2,335.

Fig. 6. A third endosiphuncle (Walcott Coll.), with still another type of diverticulation of the rayonnettes. (× ¾). M. C. Z. 2,336.

Fig. 7. *Rayonnoceras cadyi* Croneis. A longitudinal section of the neanic portion of the holotype. (× ¾). M. C. Z. 2,337.

Fig. 8. *Rayonnoceras fayettevillensis* Croneis. A polished section of the small, slightly cyrtoconic specimen referred to this species. (× ¾). M. C. Z. 2,338.

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MAY 13 1926

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
VOL. LXVII. No. 11.

REVIEW OF THE ENGRAULIDAE, WITH DESCRIPTIONS OF NEW AND RARE SPECIES.

BY DAVID STARR JORDAN AND ALVIN SEALE.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
MAY, 1926.

No. 11.— *Review of the Engraulidae, with Descriptions of new and rare Species.*

By David Starr Jordan and Alvin Seale.

This paper includes an account of the known genera of Engraulidae (Anchovies), with descriptions of the species represented in the Museum of Comparative Zoölogy, seven of which are described as new to science.

All the descriptions are the work of the junior author. The generic sequence and adjustments are chiefly the work of the senior author.

The Engraulidae are closely related to the Clupeidae (herrings) from which they differ mainly in the form and structure of the mouth.

Body more or less elongate, compressed, covered with thin, cycloid scales; head scaleless, compressed; mouth very large, oblique, usually overlapped by the short, pig-like snout; gape very wide, the maxillary typically long and slender, nearly straight, formed of three pieces, extending backwards beyond the eye, sometimes far behind the head. Premaxillaries small, not protractile, firmly joined to the maxillaries; teeth slender, usually fine and even; teeth on vomer, palatines, pterygoids, and hyoids; small, in some genera interspersed with sharp canines. Eye large, well forward, covered by an imperforate adipose eyelid; preorbital narrow; opercle thin and membranaceous, set obliquely; gill-rakers slender, usually long, often numerous. Branchiostegals slender, numerous. Gill-membranes free from the isthmus, sometimes united across it. Pseudobranchiae present; no lateral line; belly rounded, compressed or serrated. Dorsal fin short, median; anal fin with few or many rays; no adipose fin. Caudal deeply forked, sometimes preceded by a short free spine, with the lower part joined to the anal.

Small, carnivorous fishes swarming along sandy shores in most warm seas, occasionally entering rivers. Some species are valued as food, and in northern Europe a common species is pickled or crushed into paste.

The sequence of genera offers some embarrassments. It appears from palaeontology as well as from comparative anatomy that the Engraulidae are derived as a group from the Clupeidae. The presence of ventral scutes, characteristic of the herrings, is a trait not likely to be twice evolved, and this feature is found in nearly all the species of the Indian region. Such forms as Stolephorus and Scutengraulis must be nearest the primitive stock. On the other hand, the species

of simplest structure are found in the genus of temperate regions, Engraulis, and in Anchoviella of tropical America. To this group one of the fossil anchovies (Engraulites) also belongs. These species stand as the opposite to the more herring-like forms which show rather definite relationships to Ilisha and Medipellona, the nearest allied genera among the Clupeidae. The traits of these American forms are apparently due to degeneration, not to primitive simplicity, and with this point of view we have arranged the sequence of genera. The genus of simplest structure, Engraulis, is the only one of cosmopolitan distribution, and the only one confined to temperate seas, being represented on the shores of Europe, California, Chile, Japan, and Australia, while none of its species occur in the tropics.

We may note that the Coiliinae, which we place first, finds its nearest allies in Setipinna and Scutengraulis, forms with the ventral region serrated, and the teeth even. But, as usual in grouping, a natural arrangement cannot be a linear one, and we begin with this specialized offshoot from the primitive stock.

The four fossil species do not yield a satisfactory record of the origin of the group. *Engraulites remifer*, and *Engraulis brevipinnis* of the Miocene seem not far from Engraulis. The Miocene species called *Engraulis longipinnis* is certainly close to Scutengraulis and is one of the Stolephorinae, a group which theoretically ought to be older than the Engraulinae. *Engraulis evolans* of the Eocene is probably not an anchovy. It looks more like a young flying-fish, with which group some writers have placed it.

Genera of Engraulidae.

a. Coiliinae. Body greatly elongate; pectoral fin with 4 to 6 upper rays produced as slender filaments; caudal unequally forked, its lower part united to the many-rayed anal; gill-rakers 20 to 30.[1] (Asiatic genera).

x. Body very long, acute at base of caudal; anal rays 80 to 110. . . . *Coilia.*

xx. Body shorter, rounded at base of caudal; anal rays 35 to 40. *Demicoilia.*

aa. Body not greatly elongate, the anal fin free from the caudal which is strongly forked.

b. Stolephorinae. Ventral margin armed with bony scutes or serrae; body compressed; anal fin long, its insertion not far from that of dorsal; maxillary more or less broadened behind; alar scale (at base of caudal) often obsolete; gill-rakers 15 to 30. (Asiatic genera).

[1] Counted on lower limb of the first arch.

c. Uppermost ray of pectoral produced in a long filament; mouth moderate; a small free spine before dorsal; the very long anal fin beginning before origin of dorsal; alar scale present; gill-rakers 18 to 21; vertebrae 46 to 56; anal rays 50 to 75.

d. Lower jaw projecting beyond upper.....*Stethochaetus.*

dd. Lower jaw included.....*Setipinna.*

c. Uppermost ray of pectoral not produced.

e. Maxillary greatly prolonged, extending to base of pectoral or beyond; alar scale obsolete; vertebrae 41; gill-rakers 10 to 18; anal rays 35 to 40; a free dorsal spine.....*Thrissolles.*

ee. Maxillary of moderate length, not extending beyond gill-opening.

f. Insertion of anal before front of dorsal, the fin long, of 45 or 46 rays; no free spine before dorsal; canine teeth present; gill-rakers 9.....*Lycothrissa.*

ff. Insertion of anal behind front of dorsal.

g. Jaws with sharp canines; gill-rakers 14; vertebrae 48; dorsal preceded by a short, free spine; anal rays about 45; ventral scutes strong.....*Xenengraulis.*

gg. Jaws without canine teeth.

h. Dorsal preceded by a short, free spine.

i. Ventral scutes strong, developed from gill-opening to vent; vertebrae 45 to 48; anal rays about 40. *Scutengraulis.*

ii. Ventral margin with weak scutes, developed from ventrals to anal only, those almost hidden by the scales; scales firm; teeth even; no silvery lateral stripe; vertebrae 39 or 40; gill-rakers 23; anal rays 32. *Thrissina.*

hh. Dorsal fin not preceded by a free spine; ventral margin with 2 to 7 sharp scutes between pectorals and ventrals; teeth even; body translucent, usually with a silvery lateral stripe; vertebrae 39 to 43; gill-rakers 22 to 28; anal rays 15 to 37; origin of anal fin behind that of dorsal..... *Stolephorus.*

bb. ENGRAULINAE. Ventral margin rounded or compressed; without scutes so far as known; no free dorsal spine; alar scale larger. (Genera chiefly American).

k. Origin of anal fin before that of dorsal.

l. Jaws with sharp canines, those of lower jaw largest; anal rays 25 to 46; vertebrae 42; gill-rakers 19 to 21.....*Lycengraulis.*

ll. Jaws without canines, the teeth all small and even, pectoral fin very long; vertebrae 45; gill-rakers 14, anal rays 32.....*Pterengraulis.*

kk. Origin of anal fin behind that of dorsal.

m. Gill-membranes nearly separate, not united across the isthmus.

n. Pectoral fin very long, reaching tip of the long ventrals; body slender..... (Miocene). *Engraulites.*

nn. Pectoral fin short, not reaching base of ventrals.

o. Gill-rakers relatively few, 12 to 30 (49).

p. Vertebrae 46 to 47; skeleton fragile; flesh oily; body subcyclindrical, little compressed, silvery, but without lateral stripe; gill-rakers 36 to 49. *Engraulis.*

pp. Vertebrae fewer than 46; skeleton firmer; body translucent, compressed, usually with a sharply-defined, silvery, lateral stripe as in Stolephorus.

q. Mouth large; maxillary straight, narrow, somewhat pointed behind. *Anchoviella.*

qq. Mouth small, herring-like, maxillary curved, rather broad, rounded behind..... *Amplova.*

oo. Gill-rakers very many, 95 to 120; body much compressed; snout short; ventral margin sharp, but without scutes; anal fin moderate, of about 30 rays. *Anchovia.*

mm. Gill-membranes broadly united across isthmus (the membrane easily torn); gill-rakers numerous, 52 to 57; vertebrae 41; anal fin moderate, of 20 to 25 rays... *Cetengraulis.*

Coilia Gray.

Zool. misc., 1831, p. 9.
Mystus Lacépède, Hist. nat. poiss., 1803, **5**, p. 466.
Trichosoma Swainson, Nat. hist., 1839, **2**, p. 839.
Chaetomus McClelland, Calcutta journ. nat. hist., 1844, **4**, p. 405.
Leptonurus Bleeker, Verh. Batav. genootsch., 1849, **21**, p. 114.
Osteoglossum Basilewski, Nouv. mem. Soc. nat. Mosc., 1855, **10**, p. 244.

Type.— *Colia hamiltoni* Gray.

This genus is divisible into two groups, the typical one with the

maxillary barely reaching the gill-opening, the other (Chaetomus) with the maxillary extending beyond root of pectorals.

Coilia mystus (Linné).

Clupea mystus Linné, Syst. nat., ed. 10, 1758, **1**, p. 319.
Mystus clupeoides Lacépède, Hist. nat. poiss., 1803, **5**, p. 467.
Coilia clupeoides Günther, Cat., 1868, **7**, p. 404.
Coilia nasus Schlegel, Fauna Japonica. Pisces, 1846, [**4**], p. 243, pl. 100, fig. 4. Günther, Cat., 1868, **7**, p. 405.

Head 6.1; depth 6.1; dorsal I, 13; anal 80; ventral 7.[1] Six long pectoral filaments. Scales caducous, about 62 (pockets counted). Ventral profile of belly rather strongly curved, its margin sharp and armed with forty-four (17 + 27) sharp scutes. Eye 5.5 in head, being distinctly less than snout even in the young. Snout projecting, pointed, its length 3.7 in head. Mouth large, the maxillary extending to the middle of the axil of the pectoral, even in the young of 110 mm. Its length is distinctly more than head, being 5.7 in the standard length, it is broadened at the mandibular joint, but its posterior half is pointed and armed with strong teeth. The length of the mandible equals the head posterior of the middle of the eye. Teeth distinct in jaws, vomer, palatines, and pterygoids, those of the lower jaw quite small. Gill-membranes not broadly united. Gill-rakers twenty-four on the lower limb of the first arch, the longest equal to, or slightly more than eye. Opercle with a distinct oblique ridge extending back across its upper portion, anteriorly this unites with a second ridge which extends down and back. Length of opercle 3 in head, its width 1.7 in its length. Depth of V on cheeks 3.5 in head. Origin of the dorsal midway between the end of the snout and the 12th anal ray. Its base 1.8 in its longest ray, which is equal to the head posterior of the nostril. Origin of the ventrals distinctly anterior to origin of the dorsal, being a third nearer to origin of the pectoral than to origin of the anal. Length of ventral 2 in head. Origin of the pectoral is much nearer to ventrals than to eye, its length (not of filaments) almost equal to head, and its tip extending to tip of ventrals. Filaments extending to anterior third of anal, the longest 3 in the standard length. Origin of the anal posterior to the last dorsal ray by a distance which is equal to head behind the pupil. Caudal forming a tip, its upper lobe much the longest, its lower lobe united with anal.

Color silvery, without spots, back brownish, no silver lateral stripe.[2]

M. C. Z. 934. China: Hongkong. Augustine Heard. One specimen. Length 275 mm.

[1] These measurements are based on the standard length of the fish, which is the distance between tip of snout and end of last caudal vertebrae.
[2] Unless otherwise stated the colors are described from alcoholic specimens.

M. C. Z. 31,405. Mongolia: Port Arthur. Stanford University. Five specimens. Length 110–194 mm.

M. C. Z. 31,531. Japan: Tokio. Shigeho Tanaka. Four specimens. Common in southern Japan and China.

Coilia dussumieri Cuvier and Valenciennes.

Hist. nat. poiss., 1848, **21**, p. 81. Günther, Cat., 1868, **7**, p. 304. Day, Fishes of India, 1888, p. 631. Weber & Beaufort, Fish. Ind. Austr. arch., 1913, **2**, p. 50. Bleeker, Atlas ichthy., 1872, **6**, p. 140.

Leptonurus chrysostigma Bleeker, Verh. Batav. genootsch., 1849, **23**, p. 14.

Head 5.5; depth 5.2; dorsal I, 14; anal 107; ventral 7. Six long pectoral filaments. Body pointed. Scales caducous about 65–68 in lateral series (pockets counted). Profile of belly moderately curved, its margin sharp and armed with twelve (5 + 7) strong scutes. No scutes in front of pectorals. Eye equal to snout, 4.5 in head. Imperforated adipose eyelid present. Mouth large, the maxillary ending at gill-openings, its tip pointed, its length equal to head posterior of the nostrils, being 6.5 in the standard length. Mandible equal in length to the head posterior of the middle of the eye. Teeth in jaws, vomer, palatines, pterygoids, and hyoid. The teeth of jaws small but distinct. Gill-rakers twenty-two on the lower limb of the first arch, the longest 1.2 in eye, these are slim, pointed, and spinulose on the inner margin. V of cheeks 3 in head. Opercle with three to five indistinct grooves radiating back on its upper half. Length of opercle 3 in head, its width 1.5 in its length. It is largely covered by sub- and preopercular bones. Origin of the dorsal is midway between tip of the snout and a vertical line with the base of the 23rd anal ray. (Rays broken in specimens studied). Origin of the ventral is directly below the solitary spine in front of the dorsal, being midway between origin of the pectoral and the origin of the anal, its length 2.7 in head. Origin of the pectoral much nearer to ventrals than to eye, its longest ray (not the filament) equal to head posterior of the middle of eye, its tip not reaching the tip of the ventrals. The longest filament extends to anterior third of anal, its length being 3.2 in the standard length. Origin of the anal posterior of the last dorsal ray by a distance about equal to eye. Caudal ending in a tip, its upper lobe much the longer, the lower lobe united to anal by membrane.

Color silvery, below the median line there is a row of pearl-white round spots, nineteen on one side and twenty-one on the other, the number varying from seventeen to twenty-one in the same specimen. Below this row is the second row, irregular in shape. Eight to ten pearly spots on the sides of the belly, followed posteriorly by fifteen to nineteen golden yellow spots which extend to the caudal.

M. C. Z. 1,136. Straits Settlements: Singapore. C. L. Salmin. Four specimens.

M. C. Z. 17,975. Ceylon: Colombo. W. H. A. Putnam. Four specimens. Length 90–110 mm.

Coilia grayi Richardson.

Zoölogy voy. Sulphur. Ichthy., 1845, no. 10, p. 99, fig. 1, 2.

Head 6; depth 5.3; dorsal I, 13; anal 86; ventral 7. Seven long pectoral filaments. Scales 62, the grooves incomplete; there is a net-work of lines posteriorly. Ventral profile curved, its margin compressed and armed with forty (16+24) sharp scutes, seven of which are in front of pectorals. Eye equal to snout, its length 4.5 in head. Mouth large, the maxillary long, extending to below the axil of the pectoral, its length therefore much greater than head, being 4.7 in the standard length. Maxillary broadened at maxillary joint, the posterior portion being sharp pointed and armed with strong teeth. Mandible ending below the anterior margin of the opercle, its length equal to head posterior of the middle of eye. Teeth distinct in jaws, vomer, palatines, pterygoids, and hyoids, the largest ones being on the posterior portion of the maxillary. Gill-membranes not broadly united. Gill-rakers thirty on the lower limb of the first arch, the longest 1.5 in eye. These are flat, thin, and round pointed, spinulose on their inner side. Opercle with a short, oblique ridge, ending in a buried spine on the upper anterior portion. Length of opercle 3 in head, its width 1.9 in its length, its posterior margin slightly concave and with a broad membrane. Origin of the dorsal midway between the snout and a line with the base of the 18th anal ray, its longest ray much greater than the base of the fin, being equal to head behind nostrils. Origin of the ventrals but slightly anterior to origin of the dorsal being much nearer origin of the pectoral than to anal, its length equal to distance from tip of snout to posterior margin of eye. Origin of the pectoral much nearer to ventrals than to posterior margin of eye, its length (without the filaments) being equal to head posterior of the middle of the eye, its longest filament extending to anterior third of anal being 2.9 in the standard length. Origin of the anal posterior of the last dorsal ray by a distance of 2 in head. Anal united by membrane to caudal. Caudal pointed, but in reality it is forked with the upper lobe much the longer and the lower lobe which has been considered by many as a part of the anal with which it is joined.

Color silvery, grayish above. No silvery stripe. (M. C. Z. 23,281).

M. C. Z. 18,051. China. Two specimens.

M. C. Z. 18,053. China: Hongkong. W. H. A. Putnam. Four specimens. Length 170–250 mm.

M. C. Z. 23,281. China. J. D. Davis. Ten specimens. Length 185–245 mm.

M. C. Z. 31,532. ————. Jeffries Wyman Coll. One specimen.

Coilia rendahli, sp. nov.

Head 6.2; depth 6.5; dorsal I, 14; anal 92; ventral 7. Six long pectoral filaments. Scales caducous (75 pockets counted). Ventral profile moderately curved, its margin sharp and armed with fifty-two (17 + 35) strong scutes some of which are in front of pectoral. Eye equal to snout which is 4.1 in head. The snout is produced and sharp pointed. Imperforated adipose eyelid present. Mouth large, the maxillary ending at gill-openings, its length being equal to the head posterior of the nostrils or 7.1 in the standard length. The maxillary is somewhat broadened at mandibular joint, but the tip is pointed. Length of mandible equal to the head posterior of the middle of the eye. Teeth distinct in jaws, vomer, palatines, and pterygoids, those on the posterior portion of the maxillary being the largest. Gill-membranes not broadly united. Gill-rakers twenty-four on the lower limb of the first arch, the longest being 1.3 in eye, these are thin narrow, pointed, the inner margin spinulose. Opercle with some fine striae radiating back on its upper portion, also a short oblique ridge which terminates in a buried spine located on the upper anterior portion. Length of opercle 2.9 in head, its width 1.7 in its length. Depth of the V of the cheeks 2.7 in the head. Origin of the dorsal midway between tip of snout and a vertical line with the base of the 15th anal ray, its longest ray more than the base of the fin, being equal to head without the snout. Origin of the ventral but slightly anterior to the origin of the dorsal, being a third nearer to origin of the pectoral than to origin of anal, its length 2.1 in head. Origin of the pectoral distinctly nearer to ventrals than to eye, its length (without filaments) is equal to head posterior of nostrils, its tip falling short of the tip of ventrals. Filaments reaching posterior to origin of anal, the longest 3 in the standard length. Origin of the anal posterior of the last dorsal ray by a distance equal to head, anal connected to lower caudal ray by membrane. Caudal pointed, its upper lobe much the longer, the lower lobe united with anal. Length of caudal equal to head without snout.

Color silvery, without spots, somewhat brownish above. No silvery lateral stripe.

Type.— M. C. Z. 18,052. China: Shanghai. One specimen. Length 250 mm.

Paratypes.— M. C. Z. 31,530. (Orig. 18,052). China: Shanghai. Five specimens. Length 127–150 mm.

This species, named for Hjalmar Rendahl, is near *Coilia brachygnathos* Kreyenberg and Pappenheim (1909), but that species has fifty-eight ventral serrae and 101 rays in the anal fin, thus approaching *Coilia ectenes* Jordan and Seale from Korea.

Demicoilia Jordan and Seale.

Copeia, 1925, no. 141, p. 28.

Similar to Coilia, but with the posterior half of the body short and ending normally not far behind the dorsal, not prolonged and pointed as in Coilia. The depth at the base of the caudal is two to three in the depth at front of the dorsal. Anal relatively short, of thirty-five to forty rays, its posterior ray attached to the lower lobe of caudal. Pectoral filaments present. A short, free dorsal spine. Maxillary extending at least to joint of mandible. Snout pointed, projecting. Scales more or less caducous.

Type.— *Demicoilia quadragesimalis* Cuvier & Valenciennes.

The type has forty-two anal rays, hence the specific name. No pearly spots are mentioned.

Demicoilia margaritifera, sp. nov.

Head 3.7; depth 3.3; dorsal I, 13; anal 35; ventral 7. Body elongate, though much shorter than in Coilia. Depth in front of caudal 2 in head. Six pectoral filaments. Scales caducous (about 35 pockets counted). Ventral profile moderately curved, the margin compressed and armed with thirteen (5 + 8) strong scutes. No scutes in front of pectoral. Eye 4.2 in head. Snout pointed, projecting, its length 5 in head. Mouth large, the maxillary extending posterior to mandible to, or almost to, the gill-openings, its length equal to head behind the nostrils, or four in standard length. It is broadened at the mandibular joint, from which point the upper margin curves abruptly down and extends back forming a sharp point. Mandible equal to the head posterior of the front margin of eye. Teeth small in jaws, palatines, pterygoids, and hyoids; there seems to be small, probably deciduous, teeth in the vomer. Gill-membranes not broadly united. Branchiostegals ten. Gill-rakers twenty-three on the lower limb of the first arch, the longest 1.1 in eye; these are thin and pointed, with their inner margin spinulose. V-formed area of cheeks distinct, its depth 3 in head. Opercle with four or five radiating grooves on upper half, the posterior margin slightly concave. Length of opercle 2.5 in head, its width 1.5 in its length. Origin of the dorsal midway between the tip of snout and base of caudal, its base 2.5 in the length of head. The rays broken in type. Origin of the ventral slightly anterior to dorsal being nearer to origin of the pectoral than to origin of the anal, its length 2.7 in head. Origin of the pectoral slightly nearer to ventrals than to eye, its tip extending beyond ventrals. Origin of the anal posterior to the last dorsal ray by a distance equal to eye. Caudal large, its length more than head; lower lobe attached to anal.

Color silvery, brownish on sides and back. Two rows of pearl colored spots

below the median line, extending from head to caudal, the upper row of eighteen to nineteen round spots, the lower row of sixteen to eighteen spots some of which may be golden yellow. On the sides of the belly below these two rows is a third irregular row of eight or nine spots; there are also four or five spots on thorax and four or five on the under jaw.

Type.— M. C. Z. 31,533 (Orig. 17,975). Ceylon: Colombo. W. H. A. Putnam. One specimen. Length 97 mm.

Stethochaetus Gronow.

Catalogue of fishes, 1854, p. 174.
Heterothrissa Günther, Cat., 1868, **7**, p. 401.

Type.— *Stethochaetus biguttatus* Gronow.

This genus is very close to Setipinna, differing mainly in the projecting lower jaw, which is longer than in any other of the Engraulidae. Anal fin many-rayed, inserted before front of dorsal.

East Indies.

Stethochaetus breviceps (Cantor).

Engraulis breviceps Cantor, Journ. Asiatic soc. Bengal, 1850, **18**, p. 1288. Günther, Cat., 1868, **7**, p. 401. Day, Fishes of India, 1888, p. 628.
Setipinna breviceps Bleeker, Atlas ichthy., 1872, **6**, p. 137. Weber & Beaufort, Fish. Ind. Austr. arch., 1913, **2**, p. 29.
Engraulis pfeifferi Bleeker, Nat. tijd. Neder-Ind., 1852, **3**, p. 433.
Colia pfeifferi Sauvage, Bull. Soc. philom., 1882, ser. 7, **6**, p. 175.

This species we have not seen.

Stethochaetus biguttatus Gronow.

Catalogue of fishes, 1854, p. 174.

This species, said to have thirty-six anal and eleven dorsal rays, is not recognized by recent writers. The number thirty-six is no doubt a misprint, probably for sixty-three. The pectoral filament is said to be as long as the body; the lower jaw projects, and there are two dark blotches on the side. Except for this color-mark we would think the nominal species was based on *Stethochactus breviceps.*

Setipinna Swainson.

Nat. hist., 1839, **2**, p. 292.
Telara Günther, Cat., 1868, **7**, p. 400.

Type.— *Clupea telara* Hamilton.

This genus is at once distinguished by the very long uppermost ray

of the pectoral and by the very long anal fin which begins in front of the middle of the dorsal, sometimes in advance of that fin; lower jaw included.

Vertebrae forty-five or forty-six. Body rather elongate, deep anteriorly, narrowed behind; scales caducous. Ventral margin sharp, armed throughout with strong scutes. Maxillary of moderate length, broadened behind, not reaching beyond gill-opening. Teeth small, even. A small free spine before dorsal; upper ray of pectoral reaching to tip of ventrals or beyond. Anal fin very long, of fifty to seventy-five rays, its origin just before or just behind front of dorsal. No silvery stripe.

East Indies.

Setipinna telara (Hamilton).

Clupea phasa Hamilton, Fishes Ganges, 1822, p. 240, 382.
Clupea telara Hamilton, Fishes Ganges, 1822, p. 241, 382, pl. 2, fig. 272.
Setipinna megalura Swainson, Nat. hist., 1839, **2**, p. 292.
Engraulis brevifilis Cuvier & Valenciennes, Hist. nat. poiss., 1848, **21**, p. 54.

Head 6.1; depth 3.8; dorsal I, 14; anal 77; ventral 7. Vertebrae fifty-six. Pectorals large, the upper ray filiform and extending to near middle of base of anal. Scales caducous, about 54 in a lateral series. The grooves on the anterior half of each scale incomplete; the entire posterior half of scale covered with a net-work of lines, there being about ten rows of "eyes" (the term applied by fishermen to each unit of a net). Ventral profile but little curved, except the lower portion of head and below pectorals. Ventral margin very sharp and armed with nineteen (13 + 6) strong scutes. Eye 5.5 in head. An adipose eyelid covering eye. Snout little projecting, equal to eye, the jaws are practically equal. Mouth large and placed at an angle of about seventy degrees. Maxillary ending slightly posterior to distal end of mandible, but falling short of the gill-openings, its length equal to head posterior of the nostrils, its tip obliquely truncate. Mandible ending below the anterior margin of the preopercle, its length equal to head posterior of the nostrils. Teeth small, but distinct on jaws, palatines, vomer, pterygoid, and hyoid. No canines. Gill-rakers twenty-one on the lower limb of the first arch; these are wide, flat, curved, and dull pointed, their inner margin spinulate, the longest scarcely equal to eye. Opercle with three or four rather distinct grooves on its lower half and some fine longitudinal lines on its upper half. A short distinct ridge, ending in a buried spine on the upper anterior portion. Length of opercle 1.5 in head, its depth 2.5 in its width. The V of cheeks distinct, its depth 1.9 in head. Origin of the dorsal much nearer tip of snout than to posterior end of anal, its longest ray more than the base of the fin, being equal to head. Origin of ventral anterior to dorsal, but much nearer to anal than to

origin of pectoral, its length 2.5 in head. Origin of the pectoral midway between ventral and middle of eye, its length (without upper ray) equal to dorsal, its tip extending to middle length of ventrals. Origin of anal is distinctly anterior to origin of the dorsal, its base 1.7 in standard length. Caudal forked (its rays broken in the specimen studied).

Color silvery, somewhat darker above; in some specimens the ventrals are black, in others there is but little color. Margin of caudal dark.

M. C. Z. 18,050. Burma: Rangoon. W. H. A. Putnam. Two specimens. Length 215, 240 mm.

India.

Setipinna taty (Cuvier and Valenciennes).

Engraulis taty Cuvier & Valenciennes, Hist. nat. poiss., 1848, **21**, p. 60. Cantor, Journ. Asiatic soc. Bengal, 1850, **18**, p. 1288. Günther, Cat., 1868, **7**, p. 400. Day, Fishes of India, 1888, p. 628.

Setipinna taty Bleeker, Atlas ichthy., 1872, **6**, p. 136. Weber & Beaufort, Fish. Ind. Austr. arch., 1913, **2**, p. 30.

Head 5; depth 3.1; dorsal I, 14; anal 51; ventral 7. Vertebrae forty-six. The upper pectoral ray is filiform and extends about to middle of base of anal. Scales 48. The scales are peculiar in that the entire surface is covered with a fine net-work of lines. Such markings are usually confined to the posterior half or two thirds of the scale, in most species of this family. Ventral profile moderately curved, the margin sharp and armed with thirty-four (?23 + 10) scutes. Eye 4.1 in head, entirely covered with an adipose eyelid. Snout but slightly produced, its length 1.5 in the eye. Mouth large, the maxillary ending slightly posterior to end of mandible, its tip wide and obliquely truncate, its length equal to head posterior to anterior margin of the eye. Mandible ending below the lower anterior margin of the preopercle, its length slightly less than maxillary. Teeth small and distinct in jaws, palatines, pterygoids, vomer, and hyoid, no canines. Gill-rakers eighteen on the lower limb of the anterior arch, these flat, thin, the inside margin ratchet-like and spinulate, the longest equal to eye. Opercle with three or four light striae and one distinct groove on its lower half, a notch on the posterior border, a short buried spine on the upper anterior portion, and some light longitudinal lines on upper portion. Length of opercle 1.9 in head, its width 2.7 in its length. V of the cheeks distinct, its depth 2.2 in head. Origin of the dorsal midway between tip of snout and anterior end of caudal peduncle, its longest ray about twice the base, being equal to head posterior of the nostrils. Origin of ventrals anterior to dorsal being midway between origin of pectoral and ventrals, its length 2.5 in head. Origin of the pectoral midway between origin of ventral and middle of eye, its second ray about equal to longest dorsal ray, its tip extending to ventral.

Origin of anal is below the base of the 6th dorsal ray, its base 2.3 in its standard length. Caudal forked, its length more than head. No alar scales.

Color silvery, slightly darker above.

M. C. Z. 4,412. Siam. C. L. Salmin. Two specimens. Length 108, 118 mm.

M. C. Z. 24,863. Java. One specimen. Length 128 mm.

M. C. Z. 31,534 (Orig. 17,975). Ceylon: Colombo. W. H. A. Putnam. Nine specimens. Length 94–152 mm.

India.

Thrissocles Jordan and Evermann.

Genera of fishes, 1917, p. 98.
Thrissa Cuvier, Règne anim., 1817, **2**, p. 176.
Thryssa Cuvier, Règne anim., ed. 2, 1829, **3**, p. 38.

Type.— *Clupea setirostris* Broussonet.

This genus is distinguished from Stolephorus and related forms by the excessively long maxillary which extends beyond base of pectorals, in some species to base of anal. Vertebrae forty to forty-two. Body rather deep and compressed. The ventral margin armed with strong scutes from gill-opening to vent. Teeth small, even. Gill-rakers few, ten to eighteen; anal rays thirty-five to forty. Pectorals reaching ventrals. Origin of anal below last rays of dorsal; a free dorsal spine. No silvery lateral stripe.

East Indies.

Thrissocles setirostris (Broussonet).

Clupea setirostris Broussonet, Ichthy., 1782, dec. 1.
Engraulis setirostris Cuvier & Valenciennes, Hist. nat. poiss., 1848, **21**, p. 69. Günther, Cat., 1868, **7**, p. 379. Bleeker, Atlas ichthy., 1872, **6**, p. 134. Day, Fishes of India, 1888, p. 626. Günther, Fisch. Südsee, 1909, **8**, p. 379. Weber & Beaufort, Fish. Ind. Austr. arch., 1913, **2**, p. 40.
Stolephorus setirostris Bleeker, Nat. tijd. dierk., 1865, **2**, p. 291.
Anchovia setirostris Jordan & Richardson, Bull. 27, U. S. bur. fish., 1908, p. 237.
Thrissa macrognathus Bleeker, Verh. Batav. genootsch., 1849, **22**, p. 14.

This species we have not seen. A good account is given by Günther.

Thrissocles dussumieri (Cuvier and Valenciennes).

Engraulis dussumieri Cuvier & Valenciennes, Hist. nat. poiss., 1848, **21**, p. 69. Bleeker, Verh. Batav. genootsch., 1852, **24**, p. 43. Kner, Novara exped. Fish., 1867, p. 333. Day, Fishes of India, 1888, p. 627. Weber & Beaufort, Fish. Ind. Austr. arch., 1913, **2**, p. 41.
Engraulis mystax Günther, Cat., 1868, **7**, p. 397.

Head 4; depth 3.5; dorsal I, 14; anal 35; ventral 7. Vertebrae forty-one. Posterior two anal rays are somewhat thickened and united. Scales 40 caducous, almost as long as deep, the anterior half of each scale with five or six complete grooves, and three or four that are incomplete. Any or all of these may be more or less branched into a large rayed net-work. Ventral profile but little curved, its margin sharp and armed with twenty-three (16 + 7) distinct scutes. Eye 4 in head. Snout slightly projecting, its length 1.3 in eye. Mouth large, the maxillary extending to near the tip of ventrals, its length 2.5 in standard length. Mandibles ending below anterior border of preopercle, its length equal to head behind anterior margin of pupil. Teeth distinct, but small in jaws, vomer, palatines, pterygoid, and hyoid. No canines. Gill-rakers eighteen on the lower limb of the first arch, the longest scarcely equal to eye; these are flat, wide, and curved, the inner margin ratchet-like and spinulate. Opercle with a distinct groove near and parallel with its anterior margin, a hidden spur on upper anterior portion. V of cheek distinct, its depth 2.5 in head. Origin of the dorsal is nearer tip of snout than to end of caudal vertebra, its longest ray almost twice the length of the base of the fin, being greater than head behind eyes. Ventral anterior to dorsal, being nearer to origin of pectoral than to anal, its length 2.1 in head. Origin of pectoral nearer to ventral than to eye, its length equal to head behind eyes, its tip reaching to ventrals. Origin of anal under the last dorsal ray or very slightly posterior, its base 3 in the standard length. Caudal forked, much longer than head. No alar scales.

Color silvery, brownish above, no distinct markings.

M. C. Z. 17,972. Penang. W. H. A. Putnam. Four specimens. Length 110–125 mm.

M. C. Z. 17,973. Penang. W. H. A. Putnam. One specimen. Length 100 mm.

Lycothrissa Günther.

Cat., 1868, **7**, p. 399.

Type.—*Engraulis crocodilus* Bleeker.

This genus is separated from related genera by the posterior origin of the dorsal, which is behind the origin of the anal, and by the teeth of the lower jaw, which are large and canine-like.

The genus is characterized by Weber and Beaufort as follows (Fish. Ind. Austr. arch., 1913, **2**, p. 31): —

Elongate, compressed, scales moderately thin, deciduous, with irregular curved, transverse lines. Abdominal scutes only between pectoral and anus. Snout prominent. Mouth oblique. Head small. Maxillary narrow, extending to mandibular joint, its supplemental bone only partially ossified. Origin of the dorsal behind the origin of the anal, which is very long. Upper pectoral rays not produced. Teeth small on vomer, palatines, and pterygoids, those in jaws caninoid, especially a few in the lower jaw.

We have seen no species of this East Indian genus.

Lycothrissa crocodilus (Bleeker).

Engraulis crocodilus Bleeker, Nat. tijd. Neder-Ind., 1851, **1**, p. 15. Günther, Cat., 1868, **7**, p. 400.

Lycothrissa crocodilus Bleeker, Atlas ichthy., 1872, **6**, p. 125. Weber & Beaufort, Fish. Ind. Austr. arch., 1913, **2**, p. 31.

This species is well described by Günther.

Xenengraulis Jordan and Seale.

Copeia, 1925, no. 141, p. 29.

Type.— *Xenengraulis spinidens* Jordan & Seale.

This genus is near Scutengraulis, differing in the presence of canine teeth, as in Lycothrissa and Lycengraulis.

Xenengraulis spinidens Jordan and Seale.

Copeia, 1925, no. 141, p. 29.

Head 5; depth 3.2; dorsal I, 13; anal 46; ventral 7. Vertebrae forty-eight. Scales about 42–12, caducous, the grooves incomplete with very little net-work of lines showing. Body compressed, deep, the ventral margin very sharp and armed with twenty-seven (16 + 11) strong, exposed scutes six or seven of which are in front of the pectorals; eye 4.6 in head. Snout deep, not projecting beyond the lower jaw, its length 1.4 in eye. Mouth large, the maxillary extending posterior to gill-openings, but falling a little short of the base of the pectorals, its length equal to head; it is swollen at the mandibular joint, but the tip is pointed. Mandible equal to head posterior of the middle of the eye. Teeth large, canine-like, not close set, there being only about fifteen on each side of the lower jaw. These are fully as large as the teeth in *Lycengraulis grossidens*. Teeth of the maxillary somewhat less than those of the mandible, but still quite large anteriorly, graduating to small teeth on the posterior end.

Small teeth in vomer, palatines, pterygoids. Gill-rakers fourteen on the lower limb of the first arch, the longest 1.2 in eye, they are thin, curved, rounded at the tip with the inner margin spinulose. Opercle smooth except a single groove near and parallel with its anterior margin and a small hidden spine on its upper anterior portion. There is a distinct notch in the lower posterior border. Length of opercle 1.9 in head, its width 2.1 in its length. V of cheeks distinct, its depth 2.6 in head. Origin of the dorsal midway between the end of caudal vertebra and the posterior margin of eye, its base 1.9 in its longest ray. Origin of ventral far anterior to dorsal, being much nearer to origin of the pectoral than to anal pore, its length greater than distance from tip of snout to posterior margin of the eye. Origin of the pectoral about midway between origin of ventrals and posterior margin of the eye, its length equal to head without snout, its tip reaching to middle of ventral. Origin of anal is below the last ray of dorsal, its base 2.8 in the standard length. Caudal forked, its length slightly more than head, its lower lobe the longest. Enlarged scales at base of caudal.

Color silvery, brownish above, no dark venules on scapular region.

TYPE.— M. C. Z. 4,413. Siam. Length 208 mm.

PARATYPES.— M. C. Z. 1,541 (Orig. 4,413). Siam. Two specimens. Length 191, 207 mm.

M. C. Z. 18,054. India: Calcutta. W. H. A. Putnam. One specimen. Length 185 mm.

M. C. Z. 31,543 (Orig. 17,967). Burma: Rangoon. William Theobald. Two specimens. Length 175, 190 mm.

SCUTENGRAULIS Jordan and Seale.

Copeia, 1925, no. 141, p. 30.

TYPE.— *Thrissa hamiltoni* Gray.

Ventral scutes strong and exposed from head to anal pore. A distinct free spine in front of dorsal. Vertebrae forty-five. Body thin, deep and compressed to the sharp ventral margin which is armed with strong exposed scutes from head to vent. Scales thin, more or less caducous. Maxillary ending between the mandibular joint and axil of pectoral, usually extending beyond gill-openings. Teeth small and even. Gill-rakers wide set, few, twelve to twenty-five. Origin of anal under or slightly behind the posterior portion of dorsal. Sides usually without silvery stripe. Anal fin long, of about forty rays.

SCUTENGRAULIS MYSTAX (Bloch and Schneider).

Clupea mystax Bloch & Schneider, Syst. ichthy., 1801, p. 426, tab. 83.

Engraulis mystax Bleeker, Atlas ichthy., 1872, **6**, p. 132. Day, Fishes of India, 1888, p. 625.

Thryssa porava Bleeker (*nec* Hamilton), Verh. Batav. genootsch., 1849, **22**, p. 14.

Trichosoma porava Rutter, Proc. Acad. nat. sci. Phil., 1897, p. 65.

Engraulis mystacoides Bleeker, Verh. Batav. genootsch., 1852, **24**, p. 42. Günther, Cat., 1868, **7**, p. 396.

Engraulis hamiltoni Kner (*nec* Gray), Novara exped. Fish, 1867, p. 334.

Head 4.1; depth 3.5; dorsal I, 14; anal 39; ventral 7. Vertebrae forty-six. Scales 45–12, caducous. Body compressed, the ventral profile about evenly curved with the dorsal, the ventral margin sharp and armed with twenty-nine (18 + 11) sharp scutes which extend anterior to pectoral. Eye 3.7 in head, imperforated adipose eyelid present. Snout but little projecting, its length 1.2 in eye. Mouth large, the maxillary extending somewhat posterior of the gill-openings but falling short of the base of pectoral, its length equal to head posterior of the nostril. Mandible equal to head posterior of the anterior margin of the pupil. Teeth very small in jaws, vomer, palatines, and pterygoids. No canine-like teeth. Gill-membranes not broadly united. Gill-rakers twelve on the lower limb of the first arch; these are flat, curved, not very sharp pointed, and with the inner margin spinulose, the longest raker 1.5 in eye. Opercle is smooth except a single groove near and parallel with its anterior margin. Length of opercle 2.1 in head, its width 2.1 in its length, its posterior border slightly subconcave on its lower half. V of cheeks distinct, its depth 2.6 in head. Origin of dorsal is midway between the end of the caudal vertebra and the anterior margin of eye; the base of the dorsal is 1.8 in its longest ray. Ventral anterior to dorsal, being slightly nearer to origin of pectoral than to origin of anal, its length equal to distance from tip of snout to posterior margin of the pupil. Origin of pectoral slightly nearer the ventrals than to eye, its length equal to head posterior of the anterior margin of the pupil, its tip reaching ventrals. Origin of anal is under the last ray of dorsal, its base 2.9 in the standard length. Caudal forked, its length about equal to head. Alar scales present.

Color silvery, brownish above. No silvery lateral stripe. Dark punctulations on posterior portion of jaws, and tip of dorsal and caudal.

M. C. Z. 1,107. Java. C. L. Salmin. One specimen. Length 152 mm.

M. C. Z. 30,349. Penang. L. P. Ward. One specimen.

Externally this species most nearly resembles *S. malabaricus* (Cuvier and Valenciennes). The latter species, however, has twenty-five gill-rakers, fewer vertebrae (44), shorter maxillary, and the dorsal is located a little farther forward.

Scutengraulis hamiltoni (Gray).

Thrissa hamiltoni Gray (*nec Engraulis hamiltoni* Gray), Illustr. Ind. zoöl., 1836, **2**, tab. 5, fig. 6.

Engraulis hamiltoni Günther, Cat., 1868, **7**, p. 395. Day, Fishes of India, 1888, p. 625. Vinciguerra, Ann. Mus. civ. Genova, 1885, ser. 2, **2**, p. 94.
Stolephorus hamiltoni Bleeker, Nat. tijd. dierk., 1863, **1**, p. 261.
Trichosoma hamiltoni Rutter, Proc. Acad. nat. sci. Phil., 1897, p. 66.
Anchovia hamiltoni Jordan & Richardson, Bull. 27, U. S. bur. fish., 1908, p. 236.
Engraulis grayi Bleeker, Verh. Batav. genootsch., 1852, **24**, p. 41. Kner, Novara exped. Fish., 1867, p. 333.
Engraulis poorawah Bleeker, Atlas ichthy., 1872, **6**, p. 152.

Head 4.5; depth 3.2; dorsal I, 15; anal 40; ventrals 7. Vertebrae forty-five. Scales forty-five persistent, the grooves incomplete, a net-work of lines on the posterior portion of the scale. Body compressed, the ventral profile but little curved, the margin sharp and armed with twenty-seven (17 + 10) scutes, which are, however, not very prominent, being almost hidden by the scales; they extend anterior to pectorals. Eye 3.5 in head. Snout not projecting beyond tip of lower jaw; its length 1.2 in eye. Mouth large, the maxillary extending posterior to gill-openings, but falling short of the base of the pectorals, its length equal to head posterior of nostrils. Mandible equal to head posterior of the anterior margin of the pupil. Very small teeth in jaws, vomer, palatines, and pterygoids, those of jaws somewhat directed forward. No canine-like teeth. Gill-rakers twelve or thirteen on the lower limb of the first arch, the longest 1.5 in eye, these are thick, blunt, and spinulose on their inner side. Opercle smooth except a short buried spine on its upper anterior portion. Length of opercle 2.1 in head, its width 2.5 in its length, its lower anterior portion largely covered by the preopercle.

V of cheeks 1.7 in head. Origin of the dorsal midway between end of caudal vertebrae and the middle of eye; its base is contained 1.7 in its longest ray. Origin of ventrals anterior to dorsal, being midway between origin of the pectoral and the anal pore, its length equal to distance from tip of snout to middle of eye. Origin of the pectoral midway between the origin of the ventrals and the pupil, its length equal to head posterior of snout, its tip reaching ventrals. Origin of anal is under the last ray of dorsal, its base 3 in the standard length. Caudal forked, its length more than head, its lower lobe the longest.

Color silvery, brownish above; no silvery lateral stripe. Scapular region with dark venules. Under jaw powdered with dark dots.

M. C. Z. 17,969. India: Calcutta. W. H. A. Putnam. Two specimens. Length 187–191 mm.

M. C. A. 17,970. Penang. W. H. A. Putnam. One specimen. Length 170 mm.

M. C. Z. 31,535 (Orig. 17,972). Penang. W. H. A. Putnam. Eleven specimens. Length 135–140 mm.

M. C. Z. 31,537 (Orig. 17,972). Penang. W. H. A. Putnam. Ten specimens. Length 130–159 mm.

M. C. Z. 31,538 (Orig. 17,975). Ceylon: Colombo. W. H. A. Putnam. Three specimens. Length 105–140 mm.

China to east coast of India. Common.

Scutengraulis purava (Hamilton).

Clupea purava Hamilton, Fishes Ganges, 1822, p. 138, 382.

Engraulis purava Cuvier & Valenciennes, Hist. nat. poiss., 1848, **21**, p. 65. Cantor, Journ. Asiatic soc. Bengal, 1850, **18**, p. 1290. Günther, Cat., 1868, **7**, p. 397. Bleeker, Atlas ichthy, 1872, **6**, p. 135. Day, Fishes of India, 1888, p. 628.

Head 4.3; depth 3.7; dorsal I, 14; anal 40; ventral 7. Scale caducous, the scale-pits thirty-eight. Ventral profile moderately curved, the margin compressed and armed with twenty-six (17 + 9) sharp scutes. Eye 3.7 in head. Snout projecting, 1.7 in eye. Mouth large, the maxillary extending to below the lower axil of the pectoral, its tip sharp pointed; it is expanded above mandibular joint, its length distinctly more than head, mandible ending below anterior margin of preopercle, its length equal to head posterior of snout. Teeth distinct in jaws, vomer, palatines, pterygoid, and hyoids. No canines. Gill-rakers seventeen on the lower limb of the first arch. These are flat, strongly curved on their anterior third, the tip rounded, the inner margin spinulose, the longest raker 1.5 in eye. Opercle smooth except a groove near its anterior margin, and a short oblique ridge ending in a hidden spine on its upper anterior portion. Length of opercle 2 in head, its width 2.3 in its length. V of cheeks distinct; its depth 2.7 in head. Origin of dorsal midway between end of caudal vertebra and the nostril, its longest ray more than base of the fin, being about equal to head posterior of eye. Origin of ventrals anterior to dorsal, being nearer to origin of pectoral than to anal pore, their length equal to the distance from tip of snout to middle of eye. Origin of the pectoral is midway between origin of the ventrals and eye, its length about equal to postorbital portion of head, its tip reaching ventrals. Origin of the anal is under the posterior ray of dorsal, its base 3 in the standard length. Caudal forked, its length about equal to head.

Color silvery, brownish above; no distinct silvery lateral stripe. A dark venule on scapular region.

M. C. Z. 31,536 (Orig. 1,107). Java. C. L. Salmin. Two specimens. Length 104, 106 mm.

East Indian Seas.

Scutengraulis valenciennesi (Bleeker).

Stolephorus (*Thryssa*) *valenciennesii* Bleeker, Nat. tidj. dierk., 1866, **3**, p. 306.

Head 4; depth 3.2; dorsal I, 13; anal 41; ventral 7. Scales thirty-four; the grooves are chiefly incomplete, although usually two or three are complete.

The distal half of the scale is covered with a peculiar lace-like pattern. Ventral profile but little rounded, the margin sharp and armed with fifteen (7 + 8) distinct keeled scutes, each ending in a sharp spine. Eye about a third longer than snout, being 3.7 in head. Adipose eyelid well developed. Mouth large, the snout slightly projecting, the under jaw included. Maxillary extending slightly posterior to base of pectoral, its length distinctly greater than head, being 3.5 in the standard length; its distal end is pointed and but little curved, two supplemental bones present, fine teeth on its lower margin. Mandible ending under the middle of opercle, its length 1.2 in head, its greatest depth 3.5 in its length. Fine teeth in jaws, vomer, palatines, pterygoids, and tongue. Gill-rakers sixteen, the longest a fourth less than the eye. Posterior wall of the gill-chamber rounded, without soft dermal points. Opercle smooth, except a single ridge near its anterior border. Depth of opercle 2.1 in head, its width 2.7 in its length. Origin of the dorsal midway between tip of snout and base of caudal fin, its longest ray almost a half shorter than the base of the fin, being equal to distance from tip of the snout to the middle of the opercle. Origin of the ventral entirely in front of dorsal fin, being nearer to origin of the pectoral than to origin of the anal, its length equal to distance from tip of snout to posterior margin of the pupil. Origin of the pectoral midway between ventrals and the posterior margin of the eye, its length equal to distance from tip of snout to middle of opercle, its tip extending much beyond base of ventral. Base of anal long, 2.7 in the standard length. Caudal forked, about equal to length of head. No alar scales.

Color silvery, darker above with brownish shade.

Mus. Stanford Univ. 8,170. Sumatra. One specimen. Length 140 mm.

East Indies.

Scutengraulis malabaricus (Cuvier and Valenciennes).

Engraulis malabaricus Cuvier & Valenciennes, Hist. nat. poiss., 1848, **21**, p. 63. Günther, Cat., 1868, **7**, p. 395. Meyer, Ann. Soc. Esp. hist. nat., 1885, **14**, p. 42. Day, Fishes of India, 1888, p. 625.

Head 4.5; depth 3.3; dorsal I, 14; anal 40; ventral 7. Vertebrae forty-five. Scales thirty-eight, persistent, the scale-grooves for the most part incomplete but overlapping, two or three grooves may be complete; the posterior third of the scale has ten or more closely-crowded, narrow lines, the four or five posterior lines forming a net-work on the apical margin. Ventral profile moderately rounded, the margin sharp and armed with twenty-four (15 + 9) sharp scutes. Imperforated adipose eyelid present. Snout short, slightly projecting, its length 1.7 in eye. Mouth large, maxillary ending below lower anterior margin of opercle, its tip slightly posterior to gill-openings, pointed but dilated at mandibular point, its length equal to head posterior of the

nostril. Mandible ending below lower anterior margin of the preopercle, its length equal to head posterior of the middle of eye. Teeth small, on jaws, vomer, palatines, pterygoids, and hyoids. No canines. Gill-rakers twenty-five, the longest about equal to pupil; these are rather wide flat and inner margin with spinules. Opercle has indistinct striae radiating down and back, a very distinct double groove, parallel and near the anterior margin. Length of opercle 1.9 in head, its width 2.1 in its length, a shallow notch on its posterior border; V of cheeks distinct, its depth 3 in head (this is measured from eye to the inside of the apex of the angle). Origin of the dorsal midway between end of vertebra and the middle of eye, its longest ray almost twice the base of the fin, being about equal to head without the snout. Origin of the ventral anterior to dorsal, being nearer to origin of the pectoral than to the anal, its length equal to the distance from tip of snout to posterior margin of the pupil. Origin of pectoral midway between ventral and the middle of the eye, its length equal to the longest dorsal ray, its tip extending to ventrals. Origin of the anal is below the next to posterior dorsal ray, its base 3 in the standard length. Caudal forked, its length greater than head. No alar scales.

Color silvery, scapular region with black venules, tip of dorsal and caudal slightly dark. Pectorals with some dark dots.

M. C. Z. 4,290. India: Canara. Francis Day. One specimen. Length 168 mm.

Scutengraulis longipinnis (Heckel).

Engraulis longipinnis Heckel, Sitzber. Akad. wiss. Wien, 1853, **11**, p. 128.

To the neighborhood of Scutengraulis must belong *Engraulis longipinnis* Heckel from the Upper Miocene at Chiavenna. It is described as approaching *Engraulis malabaricus* Cuvier and Valenciennes. The depth of the body is greater than length of head, which is about 3 in length of body; the anal fin very long (hence the specific name) and equal to depth of body. Teeth fine, even. Type $5\frac{1}{2}$ inches long. Nothing is said of the scutes or of the insertion of the dorsal, characters presumably as in *Scutengraulis malabaricus*. This is probably the oldest fossil anchovy known.

Thrissina Jordan and Seale.

Copeia, 1925, no. 141, p. 30.

Type.— *Clupea boelama* Forskål.

Scutes small and almost hidden by the scales, and there are none in front of pectorals. Gill-rakers few.

Vertebrae thirty-nine or forty. Body only moderately compressed, not very deep. Ventral margin with scutes from pectoral to anal pore. These are of moderate size, but almost hidden by the ventral scales. Maxillary not extending posterior to root of mandible. Teeth small, even. Gill-rakers about twenty-three; anal rays thirty-two. A distinct, small, free spine in front of dorsal as in Scutengraulis. Origin of the anal posterior to last dorsal ray. Scales firm. No silvery stripe.

This Asiatic genus is between Scutengraulis and Stolephorus, distinguished from both by its limited ventral armature and from Stolephorus by the free dorsal spinule.

Thrissina boelama (Forskål).

Clupea boelama Forskål, Descript. anim., 1775, p. 72. Bloch & Schneider, Syst. ichthy., 1801, p. 429.

Engraulis boelama Cuvier & Valenciennes, Hist. nat. poiss., 1848, **21**, p. 35. Günther, Cat., 1868, **7**, p. 393. Klunzinger, Verh. Zoöl. bot. ges. Wien, 1871, **21**, p. 597. Günther, Proc. Zool. soc. London, 1871, p. 671. Bleeker, Atlas ichthy., 1872, **6**, p. 130. Day, Fishes of India, 1888, p. 626. Günther, Fisch. Südsee, 1909, **8**, p. 379.

Stolephorus encrasicholoides Bleeker, Nat. tijd. dierk., 1863, **1**, p. 236.

Engraulis encrasicholoides Kner, Novara exped. Fish., 1867, p. 333. Günther, Cat., 1868, **7**, p. 387. Bleeker, Atlas ichthy., 1872, **6**, p. 130.

Head 3.8; depth 4.3; dorsal I, 16; anal 32; ventral 7. Vertebrae thirty-nine, forty. Scales forty persistent; the anterior half of the scale has five or six incomplete lines; there are nine or ten complete bent lines. The apical portion of scale has six to eight rows of net-work of lines. Ventral profile but slightly curved, the margin not very sharp. Scutes twenty-two, two being isolated in front of pectorals, eight between pectorals and ventrals, ten posterior to ventrals. The scutes are all more or less hidden by scales. Eye 4.7 in head; snout projecting, 1.3 in eye. Mouth large, the maxillary ending on a line with end of mandible, its tip expanded and oblique, its length equal to head posterior of the anterior margin of pupil. Mandible about equal to length of maxillary. Teeth small, present in jaws, vomer, palatines, pterygoid, and hyoid. No canines. Gill-rakers twenty-three on lower limb of first arch, the longest equal to eye; these are flat with inner margin spinulate. Opercle with a single groove. The opercle is peculiar in shape in that the lower half is of much less width than usual in this family, length of opercle 1.9 in head, its greatest width 2 in its length, the width of its lower half 4 in its length. V of cheek distinct, its depth 2.5 in head. Origin of dorsal midway between end of caudal vertebra and tip of snout, its longest ray equal to head posterior of eyes. Ventral anterior to dorsal, their origin much nearer to origin of pectoral than to anal, its length 2 in head. Origin of pectoral slightly nearer ventral than to eye, its

length equal to head behind eye, its tip scarcely reaching to ventrals. Origin of anal distinctly posterior to last dorsal ray, its base 4.4 in standard length; it is almost inclosed in a deep scaly sheet. Caudal about as long as head. Alar scales present.

Color silvery, no lateral stripe.

M. C. Z. 3,740. Red Sea. Three specimens. Length 104–120 mm.

M. C. Z. 6,132. Mauritius. Nicholas Pike. Six specimens. Length 93–110 mm.

M. C. Z. 17,971. Ceylon: Colombo. W. H. A. Putnam. Fifteen specimens. Length 100–145 mm. (Description from a specimen 145 mm. in length).

The species is abundant in the Red Sea and Indian Ocean, and is recorded from Guam.

Stolephorus Lacépède.

Hist. nat. poiss., 1803, **5**, p. 382.

Type.— *Stolephorus commersoni* Lacépède.

This genus is readily distinguished by the two to seven sharp-pointed, spine-like scutes between the pectoral and ventral; in other respects much like Anchoviella, the vertebrae fewer and the bones stronger than in Engraulis.

Vertebrae thirty-nine to forty-three. Body compressed but not deep, translucent. Ventral margin compressed, with two to seven scutes, ending in long, sharp spines. Scales thin, caducous. Maxillary not extending behind the gill-openings. Teeth small. Gill-rakers eighteen to twenty-eight. Origin of the anal below or behind the middle of dorsal. A silvery lateral stripe always present.

As now limited, the species are all tropical, and confined to the Indian region. The original description of Lacépède was based on *Stolephorus commersoni*, but a species of the genus Spratelloides of the Dussumieriidae was placed first in the genus, it being unknown to Lacépède and very loosely described by Houttuyn.

At one time the senior author was disposed to substitute the name Stolephorus for Spratelloides. The case for this change is not above cavil, and it seems best to follow current custom unless there is definite warrant for abandoning it. For this reason we regard *Stolephorus commersoni* as the type of Stolephorus rather than *Atherina japonica* Houttuyn, which is a Spratelloides.

No species of Stolephorus is known from American waters, and but two, *Stolephorus evermanni* Jordan and Seale and *S. insularum* Seale, from the South Seas (Samoa and Tahiti).

Stolephorus commersonii Lacépède.

Hist. nat. poiss., 1803, **5**, p. 382. Bleeker, Atlas ichthy., 1872, **6**, p. 128. Weber & Beaufort, Fish. Ind. Austr. arch., 1913, **2**, p. 45.

Engraulis commersonianus Günther, Cat., 1868, **7**, p. 388. Day, Fishes of India, 1888, p. 629.

Head 4.2; depth 4.8; dorsal I, 15; anal 22; ventral 7. Vertebrae thirty-nine. Scales thirty-six, caducous, anteriorly the scale has three to five grooves from center to outer margin; the posterior two thirds of the scale is occupied by ten to fourteen graduated lines of net-work; the apical margin is crenulate. Ventral profile scarcely curved, the margin moderately compressed. Scutes absent except between pectorals and ventrals where there are six to eight scutes, each with a sharp spine. Eye 3.7 in head. Snout produced, 2 in eye. Mouth large, the maxillary ending exactly at gill-openings, its tip not very pointed; it is distinctly broadened above mandibular joint, and its length equal to head without snout. Mandible ending under anterior margin of preopercle, its length equal to head posterior of the middle of the eye. Teeth fine in jaws, vomer, palatines, pterygoids, and hyoids. No canines. Gill-rakers twenty-three on the lower limb of the first arch, the longest 1.5 in eye. Opercle smooth, its length 1.7 in head, its width 2.3 in its length, its lower anterior portion ending in a stiff, flat spine. Origin of dorsal midway between end of caudal vertebra and posterior margin of eye, its longest ray scarcely equal to base of the fin, being equal to head posterior of the middle of the eye. Origin of the ventrals anterior to dorsal being nearer to origin of pectoral than to anal, its length 2.2 in head. Origin of pectoral midway between ventrals and middle of eye, its length equal to head posterior of pupil, its tip falling short of ventrals. Origin of the anal is below the 9th ray of dorsal, its base 5 in standard length. Caudal forked, its length equal to head. No alar scales.

Color hyaline, a silvery lateral stripe from head to caudal becoming wider posteriorly.

M. C. Z. 17,748. Straits Settlements: Singapore. W. H. A. Putnam. 197 specimens.

M. C. Z. 17,749. Straits Settlements: Singapore. W. H. A. Putnam. One specimen. Length 40 mm.

M. C. Z. 17,968. India: Calcutta. W. Theobald. One specimen.

M. C. Z. 30,345. Penang. L. P. Ward. Two specimens.

M. C. Z. 31,539 (Orig. 17,975). East Indies. W. H. A. Putnam. 184 specimens. Length 35–60 mm.

This species is common in the Indian region.

Stolephorus indicus (Van Hasselt).

Engraulis indicus van Hasselt, Algem. konst-en letterbok, 1823, p. 329. Bleeker, Atlas ichthy., 1872, **6**, p. 127. Day, Fishes of India, 1888, p. 629. Günther, Fisch. Südsee, 1909, **8**, p. 377.

Stolephorus indicus Bleeker, Atlas ichthy., 1872, **6**, p. 127. Weber & Beaufort, Fish. Ind. Austr. arch., 1913, **2**, p. 46.

Anchovia indica Jordan & Herre, Proc. U. S. N. M., 1906, **31**, p. 638.

Engraulis balinensis Bleeker, Verh. Batav. genootsch., 1849, **22**, p. 11.

Engraulis russelli Bleeker, Verh. Batav. genootsch., 1852, **24**, p. 38. Günther, Cat., 1868, **7**, p. 390.

Head 3.9; depth 5; dorsal 14; anal 21; ventral 7. Vertebrae forty-three. The recumbent spine in front of the dorsal obsolete or inconspicuous. Scales forty, caducous. Ventral profile but little curved, about equal to dorsal, the margin somewhat compressed, the scutes between pectoral and ventral only, these are three or four and armed with long sharp spine. Eye 3.4 in head. Snout projecting, 1.3 in eye. Mouth large, the maxillary not reaching to posterior end of mandible; in no case is it extended to a line with the lower anterior border of the opercle; its tip is obliquely truncate and broad; its length is equal to head posterior of the center of the eye. Mandible equal to maxillary. Teeth small in jaws, palatines, vomer, pterygoids, and hyoids; no canines. Gill-rakers twenty-two on the lower limb of the first arch, the longest 1.7 in eye. These are flat, thin, the inner margin spinulate. Opercle smooth, its lower anterior tip pointed, its length 2.4 in head, its width 2 in its length. V of cheeks distinct, its depth 3.2 in head. Origin of dorsal midway between end of vertebra and posterior margin of eye, its longest ray equal to the base of the fin, being equal to head posterior of eyes. Origin of the ventral anterior to dorsal, being midway between anal and the origin of the pectoral. Origin of pectoral midway between ventral and pupil of eye, its length slightly more than the head behind eyes, its tip falls slightly short of ventrals. Origin of anal is below the 13th dorsal ray; its base is 5.5 in the standard length. Caudal forked, its length about equal to head.

Color hyaline, with a narrow silvery lateral stripe from head to caudal, a dark area on top of head.

M. C. Z. 1,108. Java. C. L. Salmin. One specimen. Length 95 mm.

M. C. Z: 17,974. Straits Settlements: Singapore. W. H. A. Putnam. One specimen. Length 84 mm.

East Indies.

Stolephorus waitei, sp. nov.

Head 5; depth 6; dorsal 14; anal 19; ventral 7. Scales caducous, about forty in lateral series, the grooves complete and almost free of net-work of lines. Ventral profile scarcely curved, its margin compressed with five to

seven spines between pectorals and ventrals. Eye 3.5 in head. Snout short, pointed, projecting, its length 2 in eye. Mouth large, the maxillary ending at gill-openings, its tip pointed, its length equal to head posterior of the anterior margin of the eye. Mandible ending below anterior border of the preopercle, its length equal to head behind the middle of eye. Teeth distinct but small in jaws, vomer, palatines, pterygoids, and hyoid bones. Gill-rakers twenty-three on the lower limb of the first arch, the longest 2 in eye. Opercle smooth, its posterior margin rounded, its depth 2.3 in head, its width 2 in its length. V of cheeks distinct, its depth 3.1 in head. Origin of the dorsal midway between the end of the caudal vertebra and the nostril, its longest ray equal to base of the fin or a little longer. Origin of the ventral anterior to origin of dorsal being midway between anal and origin of the pectoral, its length equal to distance from tip of snout to the middle of the eye. Origin of the pectoral midway between origin of the ventrals and the anterior margin of the pupil, its length equal to head posterior of the middle of the eye, its tip falling short of the ventrals. Origin of the anal is below the 10th dorsal ray; its base is 6 in the standard length. Caudal forked, equal to length of head, its lower lobe the longest.

Color silvery, with a slight shade of light brown. A very distinctly outlined silvery lateral stripe from head to caudal, the width of which is contained 1.5 in eye.

M. C. Z. 18,254. Queensland. C. E. Beddone. Length 110 mm. North Australia.

This species is most nearly related to *S. indicus*, but has a longer maxillary, fewer anal rays and the origin of the dorsal farther forward. In *S. indicus* the maxillary reaches only to joint of mandible.

Named for Edgar R. Waite, the Australian ichthyologist.

Stolephorus rex, sp. nov.

Head 4; depth 5.1; dorsal I 15; anal 20; ventral 7. Scales thirty-eight, caducous. Ventral profile about equal to dorsal, the margin moderately compressed. About five scutes with long, sharp spines between pectorals and ventrals as in *S. indicus*. Eye 4. Snout projecting, its length 1.1 in eye. Mouth large, the maxillary pointed and ending below the lower tip of the opercle, its point almost reaching gill-openings, the point above mandibular joint but slightly broadened, its length equal to head without snout. Mandible ending below anterior margin of the preopercle, its length equal to head posterior of the pupil. Teeth small in jaws, vomer, palatines, pterygoids, and hyoids. No canines. Gill-rakers twenty-three on the lower limb of the first arch; these are flat, narrow, spinulose on inner margin, the longest 1.5 in eye. Opercle smooth, its length 2.1 in head, its width 2.2 in its length, its posterior border rounded, without notch, its lower portion ending in a stiff, broad point.

V of cheeks distinct, its depth 3.7 in head. Origin of the dorsal midway between end of vertebra and middle of eye, its longest ray less than the base of the fin, being equal to head posterior of eye. Ventrals anterior to dorsals, being slightly nearer to anal than to origin of pectoral, their length 2.3 in head. Origin of the pectorals midway between ventrals and anterior margin of the eye, its length equal to head posterior of eye. Origin of the anal is below the base of the 10th dorsal ray; its base is 5 into the standard length. Caudal forked, its length equal to head, alar scale present.

Color hyaline, a distinct narrow silvery lateral stripe, the least width of which is directly posterior of head. A dark brown spot on nuchal region, top of orbit and top of head dusky.

Type.— M. C. Z. 4,318. India: Canara. Francis Day. One specimen. Length 130 mm.

This species differs from *S. indicus* (*russelli* Bleeker) in the longer, pointed maxillary. In *indicus* the maxillary ends at the mandibular joint. According to Günther, who had Bleeker's type, it also has a few more gill-rakers, there being but twenty in *S. indicus*. It is distinguished from *S. commersonii* by its less depth, and different location of the fins.

Stolephorus insularum, sp. nov.

Head 4.3; depth 6.9; dorsal 15; anal 20; ventral 7. Vertebrae forty-two. Scales caducous, about forty in a lateral series (the pockets counted). Ventral profile but little curved, the margin moderately compressed, and armed with two sharp spines between the pectorals and ventrals. No scutes in front of pectorals or behind ventrals. Eye 3.5 in head. Snout projecting, pointed, its length 1.5 in eye. Maxillary not extending posterior to mandible, its tip truncate, its length equal to head posterior of the anterior margin of the pupil. Mandible ending at the anterior margin of the preopercle, its length equal to maxillary. Teeth distinct in jaws, vomer, palatines, and pterygoids. Gill-membranes not broadly united. Gill-rakers twenty-eight on the lower limb of the first arch, the longest 2 in eye. These are thin, pointed, and with the inner margin spinulose. Opercle smooth, its posterior margin somewhat rounded, its length 2.5 in head, its width 2 in its length. V of cheeks short, its depth 3.7 in head. Origin of dorsal midway between end of caudal vertebra and the middle of eye, its longest ray equal to the base of the fin. Origin of the ventrals distinctly anterior to dorsal being midway between the origin of the pectoral and the base of the 4th anal ray, its longest ray equal to the distance from tip of snout to middle of pupil. Origin of the pectoral is midway between the origin of the ventrals and the anterior margin of orbit, its longest ray equal to the head posterior of the middle of the eye, its tip falling far short of the ventrals. Origin of the anal is below the 11th dorsal ray; its base is 6 in the standard length. Caudal forked, its length about equal to head.

Color light brown, with a narrow but distinct silvery lateral stripe from head to caudal, its width about equal to pupil.

Type.— M. C. Z. 17,936. Tahiti. Andrew Garrett. Length 85 mm.

Paratypes.— M. C. Z. 31,540 (Orig. 17,936). Tahiti. Andrew Garrett. Two specimens. Length 75, 92 mm.

This species is well separated from the Samoan *Stolephorus evermanni* by its much shorter anal fin.

Stolephorus extensus, sp. nov.

Head 4.7; depth 6.2; dorsal 16; anal 20; ventral 7. Vertebrae forty-three. Scale about forty, caducous. Body elongate, cylindrical, its ventral profile but little compressed, two spinules between pectorals and ventrals. Eye 3.4 in head. Snout pointed, projecting, its length 1.2 in eye. Mouth large, the maxillary ending at the mandibular joint, its tip rounded, its length equal to head posterior of the eye. Mandible ending below the anterior margin of the preopercle, its length equal to maxillary. Teeth small, but distinct in jaws, vomer, palatines, and pterygoid. No canines. Gill-membranes not broadly united. Gill-rakers twenty-seven, the longest 1.3 in eye; these are slim, flat, and pointed, their inner margin spinulose. Opercle smooth, its lower anterior portion ending in a wide, flat point or spine. Length of opercle 2.4 in head, its width 2 in its length. V of cheeks small, its depth 3.2 in head. Origin of the dorsal midway between end of caudal vertebra and the middle of eye, its length about equal to the base of the fin. Origin of the ventral anterior to dorsal being midway between origin of anal and origin of pectoral, its length 2.5 in head. Origin of the pectoral midway between ventrals and the nostril, its length equal to head posterior of eye, its tip reaching only about half the distance to ventrals. Origin of the anal below the 10th ray of dorsal, its base 6.1 in the standard length. Caudal forked, its length about equal to head.

Color light brown, a narrow silvery lateral stripe from head to caudal, its margins not very well outlined. It is narrow anteriorly; behind it broadens to the width of the pupil.

Type.— M. C. Z. 6,133. Mauritius. Nicholas Pike. One specimen.

Paratypes.— M. C. Z. 31,542. Mauritius. Nicholas Pike. Three specimens.

This species must be near *S. heterolobus* Rüppell. It has a very close relationship to *S. insularum*, but has a much shorter head and longer body, also the origin of the ventrals is a little more anterior. From *S. indicus* it differs in the increased number of gill-rakers.

Lycengraulis Günther.

Cat. 1868, **7**, p. 399.

Type.— *Engraulis grossidens* Agassiz.

This genus has the origin of the anal behind origin of the dorsal; the ventral margin is without scutes, and there is no distinct spine in front of dorsal. Some of the teeth enlarged, canine-like, as in Lycothrissa and Xenengraulis.

Vertebrae forty-two to forty-five. Body deep and compressed. Scales thin, rather firm, caducous. Ventral margin of body compressed, but without scutes. Maxillary falling short of gill-openings. Teeth unequal in size, some being caninoid. Gill-rakers twelve to twenty-four. No separate exposed spine in front of dorsal. Origin of anal below posterior third of dorsal. Pectoral usually reaching ventrals. Silvery stripe wide and diffuse.

Three species are known, two from the Brazilian fauna and one *Lycengraulis poeyi* (Kner and Steindachner) from Panama.

Lycengraulis grossidens (Agassiz).

Engraulis grossidens Agassiz, Pisc. Bras., 1829, p. 50. Günther, Cat., 1868, **7**, p. 399.
Engraulis janeiro Spix, Pisc. Bras., 1829, t. 24, fig. 1.
Engraulis dentex Cuvier & Valenciennes, Hist. nat. poiss., 1848, **21**, p. 28.

Head 4.5; depth 4.1; dorsal 15; anal 26; ventral 7. Vertebrae forty-two. Scales forty-two, on the anterior half of each scale the grooves are incomplete and oblique; on the distal half there are about five more or less complete grooves, the net-work form almost absent. Ventral profile very little curved, the margin moderately sharp, but without scutes. Eye a third more than snout, which is 4.7 in head. Snout pointed, projecting, a notch in the upper jaw. Mouth large, maxillary ending below middle of preopercle, being slightly posterior to end of mandible. Length of maxillary is equal to head posterior of the anterior margin of the pupil. Mandible equal to head posterior to middle of eye. The lower border of the maxillary is armed with curved canine teeth; the side of the mandible has about thirty large canine teeth; there are also numerous small teeth in front of the jaws and on vomer, palatines, and pterygoids. Branchiostegals numerous, the gill-membranes not broadly united. Gill-rakers eighteen or nineteen on the lower limb of the anterior arch; these are short, flat, their inner margin toothed, the longest equal to pupil. Opercle smooth, its length 2.3 in head, its width 2.1 in its length. Origin of the dorsal midway between end of the caudal vertebra and the posterior margin of the eye, its longest ray scarcely equal to base of the fin, being equal to head posterior of eye. Origin of ventral anterior to dorsal, being midway between origin

of pectoral and anal, its length equal to the distance from tip of the snout to the posterior margin of the pupil. Origin of pectoral midway between origin of ventral and the middle of eye, its length equal to head posterior of the middle of eye. Origin of the anal is under the 9th dorsal ray, its base 3.7 in the standard length. Caudal forked, distinctly longer than head. Alar scales present.

Color hyaline, a wide, silvery lateral band, not always distinct, usually so in young specimens.

M. C. Z. 970. Brazil: Rio de Janeiro. C. F. Hartt. Two specimens. Length 168, 180 mm. (Gill-rakers 21).

M. C. Z. 4,688. Brazil: Para. Nathaniel Thayer Expedition. Seven specimens.

M. C. Z. 17,943. Uruguay River. Jeffries Wyman Coll. Two specimens.

M. C. Z. 17,977. Uruguay: Montevideo. Hassler Expedition. One specimen.

M. C. Z. 17,978. Uruguay: Montevideo. Hassler Expedition. One specimen.

M. C. Z. 17,979. Uruguay: Montevideo. Hassler Expedition. One specimen.

M. C. Z. 17,980. Uruguay: Montevideo. Hassler Expedition. One specimen.

M. C. Z. 18,003. Brazil: Rio de Janeiro. Nathaniel Thayer Expedition. Ten specimens. Length 157–190 mm. (Vertebrae 43. Gill-rakers 19).

M. C. Z. 18,005. Brazil: Bahia. Louis Agassiz. Three specimens. Length 74–136 mm.

M. C. Z. 18,016. Brazil: Cachoeira. Nathaniel Thayer Expedition. Four specimens. Length, 225 mm.

M. C. Z. 18,017. Brazil: Rio Puty. Nathaniel Thayer Expedition. Three specimens. Length 235–285 mm. (Gill-rakers 12 on lower limb of the first arch; they are short, flat, and wide. Origin of dorsal midway between end of caudal vertebra and median anterior margin of opercle).

M. C. Z. 18,019. Brazil: Rio Alegre. Hartt and Copeland. One specimen.

M. C. Z. 18,021. Brazil: Rio Doce. Hartt and Copeland. One specimen. Length, 132 mm.

M. C. Z. 18,034. Brazil: Rio Grande do Sul. Capt. Harrington. Two specimens. Length 207, 210 mm. (Gill-rakers 24).

M. C. Z. 18,047. Brazil: Rio Grande do Sul. Dom Pedro. One specimen.

M. C. Z. 18,089. Brazil: Rosario. Two specimens. Length 175, 195 mm. (Gill-rakers 20, the longest 1.1 in pupil).

M. C. Z. 31,544 (Orig. 18,017). Brazil: Santos. Nathaniel Thayer Expedition. Three specimens. Length 185–225 mm.

M. C. Z. 31,560 (Orig. 18,044). Brazil: Para. Nathaniel Thayer Expedition. Three specimens. Length 135–160 mm.

Coast of Brazil; common.

Lycengraulis batesii (Günther).

Engraulis batesii Günther, Cat., 1868, **7**, p. 399.

Head 4.3; depth 5; dorsal 16; anal 26; ventral 7. Vertebrae forty-five. Scales forty, caducous. Ventral profile but little curved, the margin compressed but not particularly sharp. No scutes. Eye 5 in head; imperforated adipose eyelid present. Snout projecting, pointed, its length 1.3 in eye. Mouth large, the maxillary extending to posterior end of mandible, its length equal to head posterior of middle of eye. Mandible ending below anterior margin of the preopercle, its length equal to head posterior of the pupil. Teeth in jaws, vomer, palatines, pterygoids, and hyoid, those on the mandible are large, canine-like, about twenty-four on each side; the longest of these is 3 in pupil; the teeth on the lower margin of the maxillary are strong and curved. Gill-rakers twenty-one on the lower limb of the first arch (in specimens of 285 mm.), fifteen in young; these are short, flat, rounded at tip and spinulate on their inner margin, the longest 1.7 in pupil. Opercle smooth, its length 2.2 in head, its width 2.1 in its length. Origin of dorsal midway between end of caudal vertebra and upper anterior margin of preopercle, its longest ray more than the base of the fin. Origin of the ventral anterior to dorsal and distinctly nearer to origin of dorsal than to anal pore, its length equal to distance from tip of the snout to the anterior margin of the eye. Origin of the anal below the base of the 11th dorsal ray, its base 4.5 in the standard length, being equal to head posterior of the nostrils. Caudal forked, its length greater than head, its lower lobe the longest.

Color in life silvery, brownish above, the silvery lateral stripe broad and not well defined, a dark spot on lower lobe of caudal.

M. C. Z. 17,941. Brazil: Rio Grande. One specimen. Length 105 mm. (Dorsal 15. Anal 25. Gill-rakers 23).

M. C. Z. 18,006. Brazil: Teffe. Louis Agassiz Coll. Four specimens. Length 180–185 mm.

M. C. Z. 18,015. Brazil: Jutahy. Nathaniel Thayer Expedition. Two specimens. Length 165, 180 mm. (Depth 5.2. Gill-rakers 15).

M. C. Z. 18,620. Brazil: Rio Doce. Hartt and Copeland. One specimen. Length 285 mm.

Coast of Brazil.

Pterengraulis Günther.

Cat., 1868, **7**, p. 398.

Type.— *Clupea atherinoides* Linné.

This genus may be at once distinguished from the fact that the origin of the anal fin is anterior to that of the dorsal and the teeth in the jaws are small.

Vertebrae forty-five. Body compressed, rather deep. Scales thin, but firm. Ventral margin compressed, but without scutes. Maxillary not extending posterior to the mandible. Teeth small. Gill-rakers about fourteen. Origin of anal anterior to origin of dorsal, its rays thirty-two. A broad, diffuse, silvery lateral stripe.

Pterengraulis atherinoides (Linné).

Clupea atherinoides Linné, Syst. nat., ed. 12, 1766, **1**, p. 523.
Engraulis atherinoides Cuvier & Valenciennes, Hist. nat. poiss., 1848, **21**, p. 31.

Head 4.2; depth 3.7; dorsal 14; anal 32; ventral 7. Vertebrae forty-five. Scales forty-two, the anterior grooves on the scales incomplete, the ten or more grooves on the posterior half are crowded upon each other and are almost completely lacking the ordinary net-like arrangement of lines. The scales persistent. Ventral profile but little curved, the margin sharp, but without scutes. Eye a half more than the projecting snout, being 5 in head. Mouth large, the maxillary ending on a line with the end of the mandible, which is below the anterior margin of the preopercle, its length equal to head posterior of pupil. The mandible is about equal to maxillary in length. Teeth distinct, in several rows in jaws, vomer, palatines, and pterygoids. Gill-membranes not broadly united. Gill-rakers fourteen; these are short, flat, and toothed on the inside, the longest a third more than pupil. Opercle smooth, its length 2.1 in head, its width 2.1 in its length. The region at the upper posterior portion of the head somewhat concave. Origin of the dorsal midway between end of caudal vertebra and the posterior margin of the opercle, its longest ray more than the base of the fin, but less than head posterior of the eyes. Ventral small, far anterior to dorsal, being midway between origin of the pectoral and the origin of the dorsal, its length equal to the distance from tip of the snout to posterior margin of the eye. Pectorals very large, their length equal to head posterior of nostrils, their origin midway between ventral and eye. Origin of the anal slightly anterior on a line with the origin of the dorsal, its base 3.3 in the standard length. Caudal forked, equal to length of head.

Color hyaline, a very wide, silvery lateral band anteriorly not well defined, becoming narrowed to the width of the eye under dorsal fin.

M. C. Z. 991. Brazil: Para. C. F. Hartt. Two specimens. Length 125, 140 mm. (Gill-rakers 14).

M. C. Z. 4,687. Brazil: Para. Louis Agassiz Collection. Five specimens. Length 150–227 mm.

M. C. Z. 18,007. Brazil: Cameta. Nathaniel Thayer Expedition.

M. C. Z. 18,008. Brazil: Arary. Louis Agassiz Collection. One specimen. Length 215 mm.

M. C. Z. 18,009. Brazil: Gurupa. Nathaniel Thayer Expedition. One specimen. Length 156 mm.

M. C. Z. 31,545. Brazil. Stanford University. One specimen.

Engraulites Jordan and Gilbert.

Stanford univ. publ. Biol. sci., 1925, **4**, p. 12.

Type.— *Engraulites remifer* Jordan & Gilbert.

This extinct anchovy is near Engraulis, differing in the very long, slender-rayed ribbon-like pectoral which reaches nearly to the tip of the long ventral. It is from a Miocene deposit of diatoms, at Lompoc, Santa Barbara County, California.

Engraulites remifer Jordan and Gilbert.

Stanford univ. publ. Biol. sci., 1925, **4**, p. 12, pl. 3b.

The type of this species (Stanford University Coll. 651) is the anterior half of a small anchovy one and one half inches long, the entire length in life not far from three inches.

Head crushed, but showing the very oblique opercle and the short lower jaw peculiar to anchovies. Depth about equal to length of head, the body rather slender, as in the living *Engraulis mordax* of the California coast. Vertebrae and interspinals slender, the vertebrae not counted. Dorsal inserted about over eighth vertebra; its rays rather high, not numerous; ventrals rather long, inserted under its middle. Anal short, well behind dorsal, a few slender rays only preserved. Pectoral narrow, very long, its length about 1½ times depth of body; its rays slender and close set, its tip reaching well beyond base of ventrals, about to middle of length of that fin. Faint traces of rather small scales along back.

Engraulis Cuvier.

Règne anim., 1817, p. 98.

Encrasicholus (Commerson) Lacépède, Hist. poiss., 1803, **5**, p. 455. Fleming, Brit. anim., 1828, p. 122.

Type.— *Clupea encrasicolus* Linné.

The species of this familiar genus are known by the subcylindrical

form, the absence of a silvery lateral stripe, the absence of canines, of ventral scutes, of prolonged fins, and more positively by the feeble skeleton, the rather dark, oily flesh, and by the relatively large number of vertebrae (46 or 47) and of gill-rakers (36 to 49), the number of vertebrae increased, as is usual in fishes of cooler waters. Maxillary not reaching gill-opening, anal fin short, inserted behind front of dorsal. The alar scales, at base of caudal, are always large.

The known species of this genus are closely related, and all inhabit temperate regions. It is the only group not having its center in the tropics, and the only one of which the distribution is world-wide. Of the species *E. encrasicolus* abounds in Europe, *E. mordax* in California, *E. ringens* in Chile, *E. japonicus* in Japan, and *E. antipodium* in southern Australia and New Zealand.

Engraulis encrasicolus (Linné).

Clupea encrasicolus Linné, Syst. nat., ed. 10, 1758, **1**, p. 318.
Engraulis encrasicholus Cuvier, Règne anim., 1817, **2**, p. 175.

Head 4.6 in length to base of caudal; depth 6; dorsal rays 13; anal 19; ventral 7. Vertebrae forty-seven. Scales about forty-two, very deciduous, the grooves incomplete, parallel on the anterior portion of scale. Body cigar-shaped, the ventral profile but little curved, the margin rounded. No ventral scutes. Eye a third longer than the snout, being 3.3 in head. Mouth large, the snout conical, projecting. Maxillary ending at mandibular joint, its anterior end under nostril, its length 1.5 in head, its distal end rounded, its outline almost straight, its lower margin denticulate, its width one half of pupil. Mandible ending below the preopercle, its length 1.4 in the head, its greatest depth 4.7 in its length. Fine teeth in jaws, tongue, vomer, and palatines. Gill-rakers thirty-six on the lower limb of the first arch, the longest less than eye. Posterior wall of gill-chamber rounded. Opercle with two wide shallow hollows. The cheek, measured obliquely, greater than eye. Origin of the dorsal midway between tip of the snout and the end of the caudal vertebra, its longest ray about equal to the base of the fin, being equal to the distance from tip of the snout to the posterior margin of the postorbital. Origin of the ventrals in front of dorsal, being midway the origin of the pectorals and the anal pore; its length is equal to the distance from the top of the snout to the posterior margin of the pupil. Origin of the anal posterior to dorsal. Origin of the pectoral midway between the origin of the ventrals and the anterior margin of the pupil. Caudal forked, its length less than head. Alar scales present.

Color silvery, darker above.

M. C. Z. 3,876. Italy: Messina. Ernst Haeckel. One specimen.

M. C. Z. 17,947. Europe. Ernst Haeckel. Three specimens. Length 102–123 mm.

M. C. Z. 18,025. Italy: Venice. Theodore Lyman. Two specimens. Length 102, 112 mm.

M. C. Z. 18,039. Austria. Two specimens. Length 102, 125 mm.

M. C. Z. 24,407. Italy: Venice. D. S. Jordan. One specimen.

M. C. Z. 31,394 (Orig. 20,603). Italy: Naples. E. C. Starks. Five specimens. Length 130–137 mm.

M. C. Z. 31,546 (Orig. 18,054). France: Nice. Theodore Lyman. One specimen.

This well-known species is common on all sandy shores throughout Europe.

Engraulis mordax Girard.

Proc. Acad. nat. sci. Phil., 1854, p. 138.
Engraulis nanus Girard, Rept. Pacific R. R. surv., 1858, **10**, p. 335.

Head 3.4; depth 5.3; dorsal 14; anal 23; ventral 7. Vertebrae forty-six. Scales forty, persistent, 4–6 almost parallel grooves from center to anterior margin, 3–5 incomplete grooves on the sides, the posterior half of the scale with 6–8 more or less complete grooves, a few net-like meshes on the margin of the scale. Ventral profile scarcely curved, the body cigar-shaped. No scutes, the margin scarcely compressed. Eye 4.5 in head. Snout projecting, pointed, its length 1.4 in eye. Mouth large, the maxillary ending below the middle of the lower margin of the opercle, its tip extending slightly beyond the end of the mandible, but not to gill-opening, its length equal to head posterior of pupil, its tip pointed. Mandible ending below anterior margin of the preopercle, its length equal to head posterior of the iris. Teeth small, but distinct in jaws, vomer, palatines, pterygoids, and hyoids. No canines. Gill-membranes not broadly united. Gill-rakers forty-three on the lower limb of the first arch, the longest equal to distance from tip of snout to middle of pupil; an inner gill-membrane with branches extending up into it as in Cetengraulis. The gill-rakers are slim and pointed. Opercles and cheek covered with a fine net-work of venules, otherwise opercle smooth, its outline strongly curved, its length 2 in head, its width 2.5 in its length. V of cheek prominent, its depth 2.2 in head. Origin of the dorsal midway between the end of the caudal vertebra and posterior margin of the pupil, its longest ray equal to the base of the fin. Origin of ventral slightly anterior to dorsal, being midway between origin of pectoral and base of the fifth anal ray, its length equal to distance from tip of snout to posterior margin of pupil. Origin of pectoral midway between ventral and posterior margin of eye. Origin of anal under posterior ray of dorsal, its base 5.5 in standard length, being equal to head posterior of eye.

Caudal forked, the lower lobe the longest, being equal to head posterior of middle of eye. Alar scales large.

Color silvery, bluish above. No distinct lateral stripe.

M. C. Z. 17,994. Cal.: San Francisco. Seventy-two specimens. Length 85–124 mm.

M. C. Z. 17,995. Cal.: San Francisco. Thirty-three specimens. Length 65–102 mm.

M. C. Z. 17,997. Cal.: San Francisco. Twenty-four specimens. Length 82–150 mm.

M. C. Z. 17,998. Cal.: San Francisco. Two specimens. Length 92, 100 mm.

M. C. Z. 17,999. California. Seven specimens. Length 72–82 mm.

M. C. Z. 18,000 Cal.: San Francisco. T. G. Cary. One specimen. Length 135 mm.

M. C. Z. 18,023. Cal.: San Francisco. Alexander Agassiz. One specimen. Length 100 mm.

M. C. Z. 18,028. Cal.: San Francisco. One specimen. Length 110 mm.

M. C. Z. 18,023. California. T. G. Cary. Seven specimens. Length 135–140 mm.

M. C. Z. 18,033. Cal.: San Francisco. T. G. Cary. One specimen. Length 117 mm.

M. C. Z. 18,048. Cal.: San Francisco. Franz Steindachner. Five specimens. Length 130–154 mm.

M. C. Z. 18,122. Cal.: San Francisco. Fifty-three specimens. Length 90–145 mm.

M. C. Z. 18,129. Cal.: San Francisco. Two specimens. Length 82, 85 mm.

This species is extremely abundant along the coast of California, especially northward, often taken in great numbers in fine-meshed nets. Here described from M. C. Z. 18,048.

Engraulis ringens Jenyns.

Voyage Beagle. Fish., 1842, pt. 4, p. 136.
Engraulis pulchellus Girard, Proc. Acad. nat. sci. Phil., 1854, p. 138.

Head 3.3; depth 4.1; dorsal 16; anal 21; ventral 7. Vertebrae forty-six. Scales forty, persistent, the grooves incomplete; there is scarcely a trace of the usual net-work of lines on apical portion of scale. Ventral profile moderately curved and slightly compressed. No scutes. Eye 4.1 in head. Snout projecting, its length 1.7 in eye. Mouth large, the maxillary not extending

posterior to mandible, its length equal to head posterior of eye. Mandible ending below anterior margin of preopercle, its length equal to head posterior of orbit. Teeth small, but distinct on jaws, vomer, palatines, pterygoid, and hyoid. No canines. Gill-rakers forty-nine on the lower limb of the anterior arch, the longest equal to distance from tip of snout to pupil, a low membrane on inside of gill-rakers. Opercle smooth, its length 1.8 in head, its width 2.5 in its length. V of cheeks distinct, its depth 3 in head. Origin of dorsal midway between end of caudal vertebra and the posterior margin of pupil, its longest ray more than the base of the fin. Origin of ventrals anterior to dorsal, its origin nearer to anal than to origin of pectoral, its length equal to distance from tip of snout to posterior margin of the eye. Origin of the pectoral midway between ventral and eye, its length a third less than head posterior of eye, its tip not reaching ventrals. Origin of the anal distinctly posterior to the last dorsal ray, being usually at least half the length of the eye posterior of the dorsal. Its base is 6.5 in the standard length, being less than the length of the head, posterior of the eye. Caudal forked, its length equal to head posterior of the anterior margin of pupil. Alar scales large.

Color silvery, brownish above, the line between the colors distinctly drawn. No lateral stripe.

M. C. Z. 17,982. Peru: Callao. Hassler Expedition. Three specimens. Length 104–140 mm.

M. C. Z. 17,984. Peru: Callao. Hassler Expedition. Twenty specimens. Length 100–145 mm.

M. C. Z. 30,797. Panama. Albatross Collection. Five specimens.

This species is certainly distinct from *E. mordax*. In comparing specimens of the same length of the two species we find the following differences: — *E. ringens* is a shorter, deeper fish with an increased number of gill-rakers (49 as compared to 43 in *E. mordax*); the origin of the anal is always under the last dorsal ray in *E. ringens;* it is always posterior to dorsal in *E. mordax;* in *E. mordax* the maxillary extends posterior to mandible, while in *E. ringens* it ends before end of mandible; and in *E. mordax* the anal base is 5.5 in standard length, in *E. ringens* it is 6.5.

Engraulis japonicus Schlegel.

Fauna Japonica. Pisces, 1846, [**4**], p. 239, pl. 108, fig. 3.

Head 4; depth 6; dorsal 15; anal 19; ventral 7. Vertebrae forty-six. Scales about forty, caducous (the pits counted). Body cylindrical, the ventral profile almost straight, little compressed, no scutes. Eye 3.7 in head. Snout projecting, pointed, its length 1.2 in eye. Mouth large, the maxillary ending at mandibular joint, its length equal to head posterior of the pupil, its tip

rounded. Mandible ending below anterior margin of the preopercle, its length equal to head posterior of the anterior margin of the pupil. Teeth small, but distinct, in jaws, vomer, palatines, and pterygoids. Gill-rakers thirty-eight on the lower limb of the first arch, the longest 1.4 in eye, these are curved, thin and pointed, the inner margin spinulose. Opercle with shallow venules and pits, its length 2.3 in head, its width 2.3 in its length, its upper posterior margin curved, its lower posterior margin slightly concave. V of cheeks distinct, its depth 3.1 in head. Origin of the dorsal midway between the end of the caudal vertebra and the nostril, its base 1.2 in its length. Origin of ventrals anterior to dorsal, being midway between the origin of the dorsal and the anal pore, its length 2.3 in head, being equal to distance from the tip of the snout to the posterior margin of the eye. Origin of the pectoral is midway between the origin of the ventrals and the anterior margin of the pupil, its length slightly less than head posterior of the eyes, its tip falling far short of the ventrals. Origin of the anal posterior of the last dorsal ray by a distance equal to the eye, its base 7 in the standard length. Caudal forked, its length about equal to head without the snout, its lower lobe the longest. Alar scales very large.

Color yellowish below, bluish on back. No silvery lateral stripe.

M. C. Z. 31,409 (Orig. 362, 366, 367, 377, 386). Japan: Tokio. Shigeho Tanaka. Five specimens. Length 135–144 mm.

Generally common on the coasts of Japan, from Saghalin to Nagasaki.

Engraulis antipodum Günther.

Engraulis encrasicholus antipodum Günther, Cat., 1868, **7**, p. 386.
Engraulis antarcticus Castelnau, Proc. Zoöl. soc. Victoria, 1872, p. 186.

Head 4; depth 5.1; dorsal 15; anal 17; ventral 7. Vertebrae forty-six. No elongate rays or appendages. Scales caducous. Ventral profile but little curved, the body being cigar-shaped. Scutes not visible in badly damaged specimens. Eye 3.3 in head. Snout projecting, pointed, its length 1.5 in eye. Mouth large, the maxillary ending at joint of mandible, its tip truncate. Teeth very minute, and easily overlooked, in jaws, vomer, palantines, and pterygoids. Opercle smooth, its length 2.5 in head. Gill-membranes not broadly attached to isthmus. Gill-rakers forty on the lower limb of the first arch, the longest almost equal to eye. Origin of the dorsal midway between end of caudal vertebra and the nostril. Origin of the anal posterior to the last dorsal ray.

Color silvery, bluish above, no distinct lateral stripe.

M. C. Z. 18,036. Australia: Victoria. Two specimens. Length 103, 122 mm.

This species, closely resembling the others of the genus, is common on the shores of temperate Australia and New Zealand.

Engraulis brevipinnis Heckel.

Sitzber. Akad. wiss. Wien, 1853, **11**, p. 120.

This species from the Upper Miocene at Chiavon (Chiavenna) is very briefly described as much more slender than *Engraulis longipinnis*, and with the anal fin very much shorter, its base scarcely one third of depth of body, which is equal to the length of the head.

There is nothing in this description to separate the species from Engraulis.

Engraulis evolans (Blainville).

Clupea evolans Blainville, Nouv. dict. hist. nat., 1818, p. 344.
Exocoetus evolans Volta (*nec* Linné), Ittiolit. Veronese, 1796, p. 102, pl. 24.
Engraulis evolans Agassiz, Neues jahrb., 1835, p. 306. Poiss. foss., 1844, **5**, pt. 2, p. 321, pl. 37; fig. 1, 2.

This species, as figured by Agassiz, is slender, the depth about equal to length of head which is long and pointed, $3\frac{1}{2}$ to 4 times in body. Pectoral with ten rays, the median longest, slender and stiff, not branched, wide set, as long as head, apparently inserted high, with strong basal bones; ventrals median, similar, as long as head, the rays about eight; anal long and low, even, its base about equal to head, its rays about fifteen; dorsal represented by bases of several broken rays, the first behind front of anal, the dorsal and anal fins apparently equal in life; caudal well forked, the lobes strong, the lower a little the stronger, as long as head. Eye large; teeth small, even, no trace of ventral scutes. Mouth not clearly defined, the mandible shorter than the pointed snout; maxillary not reaching gill-opening, lower jaws pointed, sharp at tip with divergent branches below. Vertebrae stronger than in the Anchovies, forty in number.

This species, from the Upper Eocene at Monte Bolca, the earliest in time assigned to this group, may possibly be an anchovy, as supposed by Agassiz, but the probabilities seem against it. The long pectoral is composed of wide-set and rather strong rays; it is inserted rather high, and its basal bones are relatively strong; the dorsal is inserted farther back than in any anchovy, and apparently matches the long anal. The structure of the mouth is not clearly shown in the type, although possibly not unlike that of an anchovy. In fact, it seems more like a very young flying-fish than any other form. Its strong pectorals and ventrals, the backward insertion of the dorsal and the

strong lower lobe of the caudal all point in that direction, and some flying-fishes (Fodiator) have a pointed head.

There is no warrant for placing the species in Exocoetoides (Cheirothricidae) as suggested by Kramberger. In that genus the caudal fin is rounded, while in this species it is deeply forked. The species seems nearest the modern genus Exonautes, flying-fishes with the dorsal and anal equal and opposite.

Anchoviella Fowler.

Proc. Acad. nat. sci. Phil., 1911, p. 211.
Menidia Browne (*nec* Bonaparte), Hist. Jamaica, 1789, p. 441.

Type.— *Engraulis perfasciatus* Poey.

This genus is close to Engraulis, differing in the firmer, translucent substance of the body. The flesh is less oily, the skeleton more solid. Technically it differs in fewer vertebrae, fewer gill-rakers, both characters connected with its tropical habit. The body is more compressed, and the sides are usually marked with a broad silvery band as in Stolephorus. As in Engraulis the anal rays are sixteen to thirty-seven; gill-rakers fifteen to forty-three; vertebrae forty to forty-two. There are no ventral scutes, a character which distinguishes it fully from the East Indian genus Stolephorus. Usually there are no alar scales.

The characters of the genus are apparently not primitive but rather to be regarded as traits of degeneration, the origin of the group being from forms probably now extinct, but connecting it with Stolephorus.

The genus may need further subdivision as some species (*spinifera, mundeola, panamensis, compressa, eigenmannia*) have the anal fin very long, twenty-nine to thirty-seven rays, some as *rastralis* have gill-rakers in increased number.

The species are very numerous, being found on all sandy shores of tropical America. In this paper we describe only those represented in the M. C. Z.

Anchoviella perfasciata (Poey).

Engraulis perfasciatus Poey, Memorias, 1860, **2**, p. 313.
Stolephorus perfasciatus Jordan & Evermann, Bull. 47, U. S. N. M., 1896, **1**, p. 441.

Head 3.7; depth 6; dorsal 16; anal 17; ventral 7. Vertebrae forty-three. Scales caducous, about forty in a lateral series, the grooves (radii) incomplete, and not forming a net-work of lines on the apical portion of scale. The ventral

profile but little curved or compressed, approaching Engrauris in form. No scutes. Snout projecting, pointed, its length 1.6 in head. Mouth large, the maxillary ending at the mandibular joint, not extending posterior of mandible, its posterior end obtusely rounded, its length equal to head posterior of the middle of eye. Mandible ending below the anterior margin of the preopercle, its length equal to the maxillary. Teeth small, present in jaws, vomer, palatines, and pterygoids. Gill-rakers twenty-six on the lower limb of the first arch, the longest 1.3 in eye. These are rather slim, pointed, with their inner margin spinulose. Opercle smooth, its length 2.6 in head, its width 2 in its length. The V of cheeks distinct, its depth 3.2 in head. Origin of the dorsal midway between the end of the caudal vertebra and the middle of eye, its longest ray slightly more than the base of the fin, being equal to head behind the eyes. Origin of the ventrals anterior to the dorsal, being nearer to origin of the pectoral than to anal, its length equal to eye. Origin of the pectoral midway between origin of the ventrals and the anterior margin of the eye, its tip falling short of the ventrals. Origin of the anal slightly posterior of the last dorsal ray. The length of its base is 7 in the standard length. Alar scales prominent. Caudal forked, its length less than head.

Color dull yellowish brown, with a very bright and distinctly outlined silvery lateral stripe from head to caudal. The width of the center of this stripe is 1.5 in eye, while the anterior and posterior portions are 1.1 in the same organ. There is a dark margin to the upper portion of the stripe, and a dark blotch on the top of the head, and on the upper base of the caudal.

Type.— M. C. Z. 17,965 (Orig. 153). Cuba. Poey Coll. One specimen. Length 100 mm.

M. C. Z. 17,966 (Orig. 31). Cuba. Poey Coll. Two specimens. Length 87, 90 mm.

M. C. Z. 31,549 (Orig. 17,955). Cuba. Poey Coll. Nine specimens.

Florida Keys to Cuba. Common but less abundant than *Anchoviella epsetus*.

Anchoviella exigua (Jordan and Gilbert).

Stolephorus exiguus Jordan & Gilbert, Proc. U. S. N. M., 1882, **4**, p. 342.

Head 4; depth 5.5; dorsal 15; anal 21; ventral 7. Vertebrae forty-four. No elongate rays or appendages. Scales thirty-nine, caducous, ventral profile about equal to dorsal, its ventral margin moderately compressed but without scutes. Eye 3.4 in head, unperforated adipose eyelid present. Snout projecting, pointed, its length 1.2 in eye. The nostrils with slight rims. Mouth large, the maxillary extending to gill-openings; it is expended above mandibular joint but the tip is sharp pointed. Mandible ending below the anterior margin of the preopercle, its length equal to the head anterior of the middle of

eye. Teeth small, but distinct in jaws, vomer, palatines, and pterygoids. Gill-membranes not broadly joined. Gill-rakers thirty on the lower limb of the first arch, the longest 1.2 in eye. Opercle smooth except for a low rounded ridge in the center, the major portion of its posterior margin is straight, its length 2.3 in head, its width 1.7 in its length. V of cheeks distinct, its depth 3.2 in head. Origin of dorsal midway between end of caudal vertebra and posterior margin of eye, its longest ray equal to the base of the fin. Origin of the ventrals anterior to dorsal, being midway between origin of pectoral and origin of anal, its length equal to the distance from tip of snout to posterior margin of pupil. Origin of the pectoral midway between origin of ventrals and the middle of eye, its length equal to head posterior of the pupil. Origin of the anal is below the 10th ray of dorsal, its base 4.7 in standard length. Caudal forked, its length equal to head without snout.

Color light brown. An indistinct silver lateral stripe, the edges of which are moderately well outlined, it is narrow anteriorly but posteriorly is equal to the width of the eye.

Cotypes.— M. C. Z. 31,393 (Orig. 115). Mex.: Mazatlan. Stanford University. Four specimens. Length 75–82 mm.

A small and slender species. Rare on the west coast of Mexico.

Anchoviella epsetus (Bonnaterre).

Esox epsetus Bonnaterre, Ichthy., 1788, p. 175.
Atherina brownii Gmelin, Syst. nat., 1789, **1**, p. 1397.
Stolephorus brownii Jordan & Evermann, Bull. 47, U. S. N. M., 1896, **1**, p. 443.

Head $3\frac{3}{4}$; depth $4\frac{3}{4}$; eye $3\frac{1}{2}$. D. 15; A. 20; scales 40. Body rather elongate, compressed, not elevated; belly compressed, serrulate. Head rather short, the snout five in head, projecting much beyond the tip of the lower jaw. Teeth pretty strong; maxillary extending beyond base of mandible, but not quite reaching to the edge of the gill-opening. Eye large, cheeks triangular, scarcely larger than eye. Gill-rakers long, $\frac{2}{3}$ diameter of eye, about twenty in number. Anal with a sheath of scales; dorsal inserted nearer caudal than snout. Length four to six inches.

Olivaceous, translucent, sides silvery; the silvery lateral band about as wide as the eye, very distinct.

M. C. Z. 4,691. Brazil: Rio de Janeiro. Louis Agassiz. Fourteen specimens.

M. C. Z. 17,938. N. J.: Somers Point. William Stimpson. Eight specimens.

M. C. Z. 17,942. Uruguay River. Jeffries Wyman. One specimen.

M. C. Z. 17,944. Fla.: Tortugas. J. E. Mills. One specimen.
M. C. Z. 17,946. Florida. Eight specimens.
M. C. Z. 17,948. Fla.: Captiva Key. G. Würdeman. One specimen.
M. C. Z. 17,950. Florida. Theodore Lyman. Fifteen specimens.
M. C. Z. 17,952. Cuba. Poey Coll. Two specimens.
M. C. Z. 17,954. Cuba. Poey Coll. Nine specimens.
M. C. Z. 17,959. Cuba. Poey Coll. Fourteen specimens.
M. C. Z. 17,963. Cuba. Poey Coll. One specimen.
M. C. Z. 18,002. Brazil: Rio de Janeiro. Louis Agassiz. One specimen.
M. C. Z. 18,013. Brazil: Sambaia. D. Bourget. Twenty specimens.
M. C. Z. 18,027. S. C.: Charleston. J. E. Holbrook. Five specimens.
M. C. Z. 18,035. Fla.: Key West. L. F. de Pourtalès. Sixty-eight specimens.
M. C. Z. 18,038. N. Y.: Fisher's Island. J. H. Blake. Twenty-three specimens.
M. C. Z. 31,398 (Orig. 4,844). Jamaica. Stanford University. Seven specimens.
M. C. Z. 31,489. Cuba. Greenwood. One specimen.
M. C. Z. 31,550. ————. Three specimens.
M. C. Z. 31,551 (Orig. 17,976). Uruguay: Montevideo. One specimen.

Cape Cod to Uruguay. The commonest and best known species of tropical America.

Anchoviella ischana (Jordan and Gilbert).

Stolephorus ischanus Jordan & Gilbert (*nec* Gilbert & Starks), Proc. U. S. N. M., 1882, **4**, p. 340.
Anchovia starksi Gilbert & Pierson, Fishes of Panama, 1904, p. 42.

Head 3.7; depth 5.1; dorsal 13; anal 16; ventral 7. Scales caducous about forty in lateral series. Dorsal and ventral outlines almost equal, the ventral margin moderately sharp. No scutes. Eye 4 in head, imperforated eyelid present. Snout pointed, projecting its length 1.2 in eye. Mouth large, the maxillary extending posterior to mandible, but ending a little short of the gill-openings, its length equal to the head posterior of the middle of the pupil, its tip sharp pointed. Mandible ending below anterior margin of the preopercle, its length equal to maxillary. Teeth small, but distinct in jaws, vomer, palatines, and pterygoids. No canines. Gill-membranes not broadly united. Gill-rakers eighteen on the lower limb of the first arch, the longest 1.5 in eye;

these are slim and flat with the inner margin spinulose. Opercle smooth, its length 2.5 in head, its width 1.5 in its length. V of cheeks distinct, its length 2.7 in head. Origin of the dorsal midway between end of caudal vertebra and the anterior margin of eye, its longest ray about equal to the base of the fin. Origin of the ventrals anterior to dorsal, being midway between origin of the pectoral and anal, its length 2.7 in head. Pectoral midway between ventrals and middle of pupil. Origin of anal below the last ray of dorsal, its base 6 in standard length. Caudal forked, its length less than head. Alar scales present.

Color hyaline, a silvery lateral stripe, narrow from head to caudal, its width at center slightly less than eye; the width is less directly behind head and in front of the caudal.

M. C. Z. 23,286. Panama. Alexander Agassiz. Eight specimens.

M. C. Z. 27,876 (Orig. 46,692). Mex.: Magdalena Bay. U. S. N. M. One specimen. Length 75 mm.

M. C. Z. 29,437. Mex.: Acapulco, U. S. B. F. Nine specimens. Length 45–50 mm.

Magdalena Bay to Panama, replacing as geminate species, *Anchoviella epsetus* which it much resembles. Quite as close is *Anchoviella arenicola* from Panama, a more slender species.

Anchoviella delicatissima (Girard).

Engraulis delicatissimus Girard, Proc. Acad. nat. sci. Phil., 1854, p. 154.

Dorsal 13; head 4.4; depth 5.4; anal 23; ventral 7. Vertebrae forty-five. Scales forty, caducous, the grooves incomplete, and the net-work of lines apparently absent. Ventral profile scarcely curved, the margin but moderately compressed, with no scutes. Eye 3 in head. Snout projecting, its length 1.4 in head. Mouth large, the maxillary extending posterior to the end of the mandible, but falling short of the gill-openings, its tip being on a line with the middle of the opercle. It is expanded at the mandibular joint, but the tip is pointed. It is equal in length to head without the snout. Mandible ending on a line with the anterior margin of the preopercle, its length slightly less than maxillary. Teeth very small, in jaws, vomer, palatines, pterygoids, and hyoids. No canines. Gill-membranes not broadly united, gill-rakers thirty-three, the longest 1.3 in eye; these are thin, curved, pointed, their inner margin spinulose. Opercle smooth, its length 2.2 in head, its width 2 in its length. The V of cheeks not very marked, its depth 4 in head. Origin of the dorsal midway between end of the caudal vertebra and the posterior margin of eye, its longest ray equal to the base of the fin, being equal to head behind eyes. Origin of the ventrals anterior to dorsal, being distinctly nearer to origin of the pectoral than to anal, its length equal to distance from tip of snout to posterior

portion of the pupil. Origin of the pectoral midway between origin of the ventrals and the anterior margin of the eye, its length equal to the distance from tip of the snout to opercle, its tip falling far short of the ventrals. Origin of the anal under the 10th ray of the dorsal, its base 4 in the standard length. Caudal forked, its length about equal to head. Alar scales present.

Color hyaline, with a distinct silver lateral stripe, rather narrow anteriorly, broadening to the width of the pupil posteriorly. Top of head dark, some dark dots on the dorsal surface, especially on the upper base of the caudal.

M. C. Z. 17,992. Cal.: San Diego. Hassler Expedition. Ten specimens.

M. C. Z. 17,993. Cal.: San Diego. Hassler Expedition. Seven specimens.

M. C. Z. 17,996. Cal.: "San Francisco"? Eleven specimens. Length 63–68 mm.

M. C. Z. 27,396. Cal.: San Diego. C. H. Eigenmann. Three specimens. Length 60–63 mm.

M. C. Z. 31,401 (Orig. 6,845). Cal.: San Diego. Stanford University. Three specimens. Length 66–74 mm.

M. C. Z. 31,544 (Orig. 17,989). Cal.: San Diego. Hassler Expedition. Thirty-seven specimens. Length 65–73 mm. (Gill rakers 30).

M. C. Z. 31,555 (Orig. 17,990). Cal.: San Diego. Nine specimens.

Common from San Diego Bay southward along the coast of lower California. Not noticed north of Santa Barbara.

Anchoviella cubana (Poey).

Engraulis cubanus Poey, Synopsis, 1865, p. 420.
Stolephorus cubanus Jordan & Evermann, Bull. 47, U. S. N. M., 1896, **1**, p. 445.

Head 4.2; depth 5.7; dorsal 16; anal 21; ventral 7. Vertebrae forty-three. Scales about forty, caducous, the grooves incomplete, the net-work of radii absent in the few scales we have seen. Ventral profile but little curved, being about equal to the dorsal. Ventral margin but little compressed. No scutes. Eye 3.1 in head. Snout pointed, projecting, its length 1.2 in snout. Mouth large, the maxillary extending posterior to mandible, reaching to opercle. Its tip is pointed and its greatest width at mandibular joint, its length is equal to head behind the anterior margin of the pupil. Teeth small, in jaws, vomer, palatines, and pterygoids, no canines. Gill-rakers thirty-four on the lower limb of the first arch, the longest slightly less than eye, these are rather wide, flat, and pointed, the inner margin spinulose. Opercle smooth, its length 2.1 in head, its width 2 in its length, its lower anterior margin not ending in a sharp spine. The V of the cheeks distinct, its depth 3.5 in head. Origin of the dorsal

midway between the end of the caudal vertebra and the posterior margin of eye, its longest ray but little more than base of the fin, being equal to head posterior of the middle of the eye. Origin of the ventral anterior to dorsal, being nearer to origin of the pectoral than to the origin of the ventral. Its length equal to distance from tip of snout to pupil. Origin of pectoral midway between ventrals and the anterior margin of eye, its length equal to head posterior of the eye, its tip not reaching ventrals. Origin of the anal under the 10th ray of dorsal, its base 5 in the standard length. Caudal forked, its length probably about equal to head, the rays broken in type. Alar scales prominent.

Color yellowish light brown, a silvery lateral stripe, about equal to width of eye, extending from head to caudal; this is of less width anteriorly.

Cotypes.— M. C. Z. 17,958. Cuba. Poey Coll. Four specimens. Length 60–63 mm.

M. C. Z. 31,547 (Orig. 17,959). Cuba. Poey Coll. Nine specimens. Length 60–65 mm.

This species resembles *A. epsetus* somewhat, but has an increased number of gill-rakers, and less distinct lateral stripe. It is rather common along the shores of Cuba and Porto Rico.

Anchoviella lucida (Jordan and Gilbert).

Stolephorus lucidus Jordan & Gilbert, Proc. U. S. N. M., 1882, **4**, p. 341.

Head 3.9; depth 3.4; dorsal 13; anal 29; ventral 7. Vertebrae forty-one. Scales thirty-six, caducous. Ventral profile moderately curved, the margin sharp, but without scutes. Eye 3.5 in head. Snout 1.7 in eye; it is projecting and pointed. Mouth large, the maxillary extending slightly posterior to mandible, but falling short of the gill-openings, its tip sharp pointed. Mandible ending below the anterior margin of the preopercle, its length equal to head posterior of the middle of the eye. Teeth small, but distinct in jaws, vomer, palatines, and pterygoids. No canines. Gill-rakers nineteen on the lower limb of the first arch, the longest 2 in eye, these are thin, flat and not very sharp, their inner margin spinulose. Opercle smooth except for a low rounded ridge in its center, its posterior border convex, its length 2.2 in head, its width 1.7 in its length. V of cheeks distinct, its depth 3.3 in head. Origin of the dorsal midway between the end of the caudal vertebra and the middle of eye, its longest ray more than the base of the fin, being equal to head behind the eyes. Origin of the ventrals anterior to the dorsal, being midway between the origin of the pectoral and origin of the anal, its length equal to the distance from tip of the snout to the posterior margin of the pupil. Origin of the pectoral midway between ventral and eye, its length equal to the head posterior of the middle of the pupil, its tip reaching ventrals. Origin of the anal under the last dorsal ray, its base 3.5 in the standard length. Caudal forked, its length about equal to head.

Color light brown, a rather indistinct silvery lateral stripe, narrow with diffuse margins, it expands on the base of caudal, dark spot on top of head, and two rows of black dots on the dorsal region. Tip of caudal dusky in some specimens.

M. C. Z. 31,403 (Orig. 32). Mex.: Mazatlan. Stanford University. Two specimens. Length 75, 82 mm.

West coast of Mexico.

Anchoviella peruana (Steindachner).

Engraulis peruanus Steindachner, Sitzber. Akad. wiss. Wien, 1880, **80**, p. 173.

Head 3.5; depth 4; dorsal 16; anal 27; ventral 7. Vertebrae forty-one. Scales about thirty-six, anterior half of scale with 5–8 longitudinal lines from center, and five incomplete lines, which are almost at right angles to these, the posterior half of scale with 2–4 curved lines scarcely any net-work of lines. Ventral profile almost straight, its margin compressed but without scutes. Eye 4.3 in head. Snout projecting, prominent, pointed, with a distinct notch on its under side, its length about equal to eye. Mouth large, the maxillary ending below the lower median portion of preopercle, its tip scarcely posterior to end of mandible, its length equal to head posterior of the middle of eye, mandible ending below the anterior half of the preopercle, its anterior tip under anterior margin of eye, its length equal, head posterior of the pupil. Teeth small, but perfectly distinct in jaws, vomer, palatines, pterygoids, and hyoids. No canines. Gill-rakers twenty-six on the lower limb of the first arch, the longest equal to snout, a very narrow membrane inside of the gill-rakers. Opercle smooth, curved, its length 2 in head, its width 2.5 in its length. Origin of dorsal midway between end of caudal vertebra and the posterior margin of eye, its longest ray greater than the base of the fin, but slightly less than head posterior of the eye. Origin of the ventrals anterior to dorsal, being much nearer to origin of pectoral than to anal pore, its length equal to distance from tip of snout to posterior margin of eye. Origin of pectoral distinctly nearer ventrals than to eye, its length equal to longest dorsal ray. Origin of the anal under the 10th dorsal ray, its base 4.5 in the standard length, being equal to head posterior of the anterior margin of pupil. Caudal forked, its lower lobe the longest, being equal to head. No alar scale.

Color silvery, brownish above, a wide indistinct silvery lateral stripe, more distinct in young.

M. C. Z. 17,983. Peru: Callao. Hassler Expedition. Seventeen specimens. Length 100–140 mm.

Coast of Peru.

Anchoviella astilbe (Jordan and Rutter).

Engraulis astilbe Jordan & Rutter, Proc. Acad. nat. sci. Phil., 1897, p. 95.

Head 4; depth 5.8; dorsal 15; anal 20; ventral 7. Vertebrae forty-four. Scales about forty, caducous (the pockets counted). Body cylindrical, the ventral margin slightly compressed and without scutes. Eye 3.5 in head, imperforated adipose eyelid present. Snout projecting, pointed, its length 1.2 in eye. Mouth large, the maxillary extending to gill-openings, its tip sharp pointed. Mandible ending below anterior margin of preopercle, its length equal to head posterior of the middle of eye. Teeth very small, but present in jaws, vomer, palatines, pterygoid. No canines. Gill-rakers thirty on the lower limb of the first arch, the longest 1.3 in eye. Opercle smooth, its length 2 in head, its width 1.8 in its length, its posterior margin rounded. V-shaped figure of cheeks distinct, its depth 3 in head. Origin of the dorsal midway between the end of the caudal vertebra and the posterior margin of eye, its longest ray equal to the base of the fin. Ventrals anterior to dorsal, being slightly nearer to origin of pectorals than to anal. Origin of the pectorals midway between the ventrals and the middle of eye, its length equal to head posterior of the eye, its tip falling far short of ventrals. Origin of the anal is below the 9th dorsal ray, its base is 5 in the standard length. Caudal forked, its length about equal to head. Alar scales present.

Color hyaline, an indistinct light silvery stripe from head to caudal, the margins of which are not distinctly marked, its width less than eye.

Cotypes.— M. C. Z. 31,392. Jamaica. J. S. Roberts. Stanford University. Nine specimens. Length 49–70 mm.

Jamaica.

Anchoviella argyrophanus (Cuvier and Valenciennes).

Engraulis argyrophanus Cuvier & Valenciennes, Hist. nat. poiss., 1848, **21**, p. 49.

Stolephorus eurystole Swain & Meek, Proc. Acad. nat. sci. Phil., 1884, p. 34.

Head 3.9; depth 5.7; dorsal 14; anal 18; ventral 7. Vertebrae forty-four. Body cylindrical, the belly scarcely compressed, no scutes. Scales caducous, about forty pockets. Eye 4.7; snout projecting, pointed, its length almost equal to eye. Mouth large, the maxillary ending at mandibular joint, its tip truncated. Teeth distinct in jaws, vomer, palatines, and pterygoid. Gill-rakers thirty, as long as snout. Opercle smooth except a small knob on upper anterior portion. Length of opercle 2.2 in head, its width 2.5 in its length, its posterior margin rounded. V-shaped area of cheeks distinct, its depth 3 in head. Origin of dorsal nearer tip of snout than to the end of the caudal vertebra. The origin of the ventral is but slightly anterior to origin of the

dorsal. The origin of the anal is posterior of the last dorsal ray by a distance equal to eye, its base is 6.8 in the standard length.

Color brown, with a distinct, sharply-outlined silver stripe from head to caudal, its greatest width in the center where it is equal to eye.

M. C. Z. 27,592. Mass.: Provincetown. J. H. Blake. One specimen. Length 94 mm.

This rare species drifts northward in the Gulf Stream, to Cape Cod. The type of *Engraulis argyrophanus* examined by Dr. Jordan in Paris is regarded by him as identical with *Stolephorus eurystole* from Cape Cod. The smaller number of vertebrae and of gill-rakers as well as its tropical habit would seem to range this species and others with Anchoviella rather than with Engraulis.

Anchoviella purpurea (Fowler).

Engraulis purpurea Fowler, Proc. Acad. nat. sci. Phil., 1900, p. 497.

Head 3.7; depth 7; dorsal 14; anal 16; ventral 7. Vertebrae forty-four. The last anal ray is distinctly longer than those immediately proceeding it. Scales caducous, forty-two in lateral series (pockets counted). Body cylindrical, the ventral margin but little compressed and without scutes. Eye 3.7 in head. Snout projecting, pointed, its length 1.2 in eye. Mouth large, the maxillary not extending posterior to mandible, its length equal to head posterior of the middle of eye. Mandible ending below the anterior margin of the preopercle, its length slightly more than maxillary. Teeth small, but distinct in jaws, vomer, palatines, and pterygoids. No canines. Gill-membranes not broadly joined. Gill-rakers twenty-eight on the lower limb of the first arch, the longest 1–5 in eye. Opercle smooth, its posterior border rounded, its length 1.7 in head, its width 1.8 in its length. V of cheeks distinct, its depth 3 in head. Origin of the dorsal midway between the end of the caudal vertebra and the anterior margin of eye, its longest ray slightly more than the base of the fin. Ventrals but little anterior to dorsal, being distinctly nearer to anal than to origin of pectoral, its length equal to the distance from tip of snout to middle of the eye. Origin of the pectoral midway between the ventrals and the eye, its length equal to the head posterior of eye, its tip falling far short of the ventrals. Origin of the anal distinctly posterior to the last dorsal ray, its length 6.7 in the standard length. Caudal forked, its length less than head. Alar scale present.

Color brownish, a distinct silver lateral stripe from head to caudal, the edges of which are well defined, its width less than eye, it is of slightly less width anteriorly and posteriorly.

M. C. Z. 17,935. Oahu: Honolulu. Andrew Garrett. Six specimens. Length 40–65 mm.

M. C. Z. 28,951. Oahu: Honolulu. U. S. B. F. Six specimens. Length 42–66 mm.

M. C. Z. 31,391 (Orig., 7,650). Oahu: Honolulu. Jordan Collection. Nine specimens. Length 45–60 mm.

This species is very abundant on sandy shores of Oahu and is largely used as bait. It seems to be a true Anchoviella, as is also *Anchovia apiensis* Jordan and Seale from Samoa. *Anchovia evermanni* Jordan and Seale, from Samoa, belongs to Stolephorus as here defined.

Anchoviella choerostoma (Goode).

Engraulis choerostomus Goode, Amer. journ. sci., 1874, ser. 3, **8**, p. 125.

Head 3.2; depth 5.7; dorsal 13; anal 23; ventral 7. Scales about thirty-eight, caducous. Ventral profile scarcely curved, its margin moderately compressed. No scutes. Eye 4 in head, snout long, projecting, pointed, its length equal to eye. Mouth large, the maxillary extending posterior of the end of mandible, but falling slightly short of the gill-openings, its length equal to head posterior of the anterior margin of eye, its tip pointed. Length of mandible slightly less than that of maxillary. Teeth small in jaws, vomer, palatines, pterygoids, and hyoids. Gill-rakers twenty-four on the lower limb of the first arch, the longest slightly more than eye. Opercle smooth except a low rounded ridge in the center. The upper posterior margin is slightly concave, thus forming a slight point on the extreme posterior margin. Length of opercle 2.3 in head, its width 2.7 in its length. V of cheeks large, its depth 2.5 in head. Origin of the dorsal midway between the end of the caudal vertebra and the middle of eye, its longest ray distinctly greater than the base of the fin. Origin of the ventral anterior to dorsal being slightly nearer to anal than to origin of the pectoral, its length equal to the distance from the tip of snout to posterior margin of the pupil. Origin of the pectoral midway between origin of the ventrals and the posterior margin of the eye, its length equal to head posterior of the eye, its tip falling short of the ventrals. Origin of the anal is below the last ray of dorsal, its base is 4.7 in the standard length. Caudal forked, its length less than head.

Color light brown, with a distinct silver lateral stripe which is about equal to width of eye, some dark dots on its upper margin.

M. C. Z. 18,024. ————. Alexander Agassiz. One specimen.

M. C. Z. 23,296. Panama: East Coast. Watson. Three specimens.

M. C. Z. 28,848. Porto Rico: Fajardo. U. S. B. F. Four specimens. Length 38–44 mm.

Bermudas and southward. Common in Hamilton Harbor, Bermuda.

Anchoviella mitchilli (Cuvier and Valenciennes).

Engraulis mitchilli Cuvier & Valenciennes, Hist. nat. poiss., 1848, **21**, p. 50.
Engraulis louisiana Le Sueur. Cuvier & Valenciennes, Hist. nat. poiss., 1848, **21**, p. 51.
Engraulis duodecim Cope, Trans. Amer. philos. soc., 1866, **13**, p. 405.

Head 4; depth 4.1; dorsal 13; anal 27; ventral 7. Vertebrae forty-one. Scales caducous, thirty-eight in a lateral series (the pockets counted). Body rather short and compressed. The ventral profile moderately curved, its margin sharp but without scutes. Eye 3.2 in head. Snout produced, pointed, its length 2 in eye. Mouth large, the maxillary extending posterior to mandible, but falling a slight distance short of gill-openings, its tip sharp pointed. Mandible ending below the anterior margin of the preopercle, its length less than the maxillary. Teeth distinct in jaws, vomer, palatines, and pterygoids. No canines. Gill-rakers twenty-four, the longest 1.5 in eye. Opercle with a single low ridge in its center, its posterior border concave, a small point thus formed at its lower posterior border. Length of opercle 1.6 in head, its width 2.7 in its length. V of cheeks distinct, its depth 3.2 in head. Origin of the dorsal midway between end of caudal peduncle and the upper anterior margin of the opercle, its longest ray about equal to the base of the fin. Origin of the ventrals anterior to dorsal, being midway between the origin of the pectoral and origin of the anal, its length equal to the distance from tip of snout to middle of the eye. Origin of the pectoral midway between origin of ventrals and middle of eye, its length equal to the head posterior of the middle of eye, its tip scarcely reaching ventrals. Origin of anal is below the 6th ray of dorsal, its base is 3.7 in the standard length. Caudal forked, its length much greater than head.

Color light yellowish brown, a more or less distinct lateral stripe from head to caudal, its margins indistinct, its width less than eye.

M. C. Z. 17,939. N. J.: Somers Point. William Stimpson. Five specimens. Length 28–55 mm.

M. C. Z. 17,940. N. J.: Somers Point. William Stimpson. Four specimens.

M. C. Z. 17,949. Florida. J. E. Holbrook. Three specimens. Length 49–54 mm.

M. C. Z. 17,956. Cuba. Poey Coll. Three specimens. Length 55–70 mm.

M. C. Z. 18,004. Brazil. Louis Agassiz. Sixty-four specimens. Length 48–68 mm.

M. C. Z. 18,012. Brazil: Pernambuco. Nathaniel Thayer Expedition. Eight specimens.

M. C. Z. 18,026. S. C.: Charleston. Louis Agassiz. One specimen.

M. C. Z. 31,399 (Orig. 21,382). Louisiana. D. S. Jordan. Four specimens. Length 67–80 mm.

M. C. Z. 31,548. Va.: Ft. Monroe. Mrs. C. N. Willard. One specimen.

M. C. Z. 31,552 (Orig. 17,938). N. J.: Somers Point. William Stimpson. Three specimens.

M. C. Z. 31,553. ————. Twenty-two specimens.

Ranges from the West Indian region, northward to Cape Cod, entering sandy streams in abundance.

Anchoviella januaria (Steindachner).

Engraulis januarius Steindachner, Sitzber. Akad. wiss. Wien, 1880, **80**, p. 178.

Head 4.1; depth 4.5; dorsal 17; anal 20; ventral 7. Vertebrae forty. Scales about thirty-eight, persistent, the grooves complete in the center of the scale, with three or four short lines anteriorly and two or three rows of net-work of lines posteriorly. Posterior margin of scales crenulate. Body rather deep, the margin compressed, but without scutes. Eye 3.3 in head. Snout projecting, pointed, its length 1.7 in head. Mouth large, the maxillary not extending posterior to end of mandible, the tip not very sharp, its length equal to head posterior of the anterior margin of the eye. Mandible scarcely less than maxillary. Very small teeth in jaws, vomer, palatines, and pterygoids. Gill-membranes not broadly united, gill-rakers twenty-three, the longest scarcely equal to pupil. Opercle smooth, its posterior margin slightly concave, forming a slight point at its lower border, as in *A. mitchilli*. Length of opercle 2.2 in head, its width 1.5 in its length. Origin of dorsal midway between the end of the caudal vertebra and the posterior margin of the eye. Origin of the ventrals distinctly anterior to dorsal. Origin of the pectoral is midway between the origin of the ventrals and the middle of eye, its tip falling far short of ventrals. Origin of the anal is below the 8th dorsal ray. Caudal forked, its length about equal to head.

Color light brownish, a distinctly outlined silver stripe from head to caudal, this graduating in width from the head, where it is about as wide as the pupil to the base of the caudal, where it is half as wide as the eye, it then spreads over the base of the caudal.

M. C. Z. 4,692. Brazil: Rio de Janeiro. Two specimens. Length 47–55 mm.

M. C. Z. 31,400 (Orig. 22,089). Brazil. Stanford University. Seven specimens.

Coast of Brazil.

Anchoviella curta (Jordan and Gilbert).

Stolephorus curtus Jordan & Gilbert, Proc. U. S. N. M., 1882, **4**, p. 343.

Head 4; depth 5; dorsal 14; anal 23; ventral 7. Vertebrae forty-one. Scale thirty-six, caducous (the pockets counted). Ventral profile but slightly curved, its margin compressed, but without scutes. Eye 3.1 in head. Snout projecting, pointed, its length 1.5 in eye. Mouth large, the maxillary extending slightly posterior to mandible, but falling short of the gill-openings, its length equal to head behind the posterior margin of the pupil, its tip rather sharp pointed. Mandible ending below anterior margin of the preopercle, its length slightly less than the maxillary. Teeth small, but present in jaws, vomer, palatines, and pterygoids. No canines. Gill-rakers twenty-five on the lower limb of the first arch, the longest 1.5 in eye. Opercle smooth except a single low ridge in the center, the posterior margin concave, forming a point where it meets the subopercle. Length of opercle 2.4 in head, its width 2 in its length. V of cheeks distinct, its depth 3.7 in head. Origin of the dorsal midway between end of caudal vertebra and the posterior margin of the pupil, its longest ray equal to the base of the fin. Origin of the ventral anterior to dorsal, being slightly nearer to origin of the pectorals than to origin of anal. Origin of the pectoral midway between origin of ventral and anterior margin of the eye, its length more than head posterior of eye, its tip falling a little short of ventrals. Origin of the anal is below the 8th dorsal ray, its base 4 in the standard length. Caudal forked, its length equal to head.

Color yellowish brown. A silvery lateral stripe about the width of eye, from head to caudal, but usually more distinct posteriorly, this stripe diffused and almost obsolete in some specimens.

Cotypes.— M. C. Z. 31,402 (Orig. 2,694). Mex.: Mazatlan. C. H. Gilbert. Twenty-one specimens. Lengths 40–53 mm.

This species is locally abundant about Mazatlan, in the muddy estuary.

Anchoviella compressa (Girard).

Engraulis compressus Girard, Rept. Pacific R. R. surv., 1858, **10**, p. 336.

Head 4; depth 3.9; dorsal 13; anal 30; ventral 7. Vertebrae forty. Scales caducous, thirty-six in a lateral series. The grooves on the anterior half of the scale incomplete and more or less radiating, the grooves on the posterior portion of the scale with ten grooves complete or nearly so, the net-work form confined to about three rows at the tip. Ventral profile but little curved, the margin rather dull and without scutes. Snout short, little projecting, its length 2 in eye. The eye is 3.3 in head. Mouth large, the maxillary ending below the anterior lower border of the preopercle, its tip on a line with the end of the mandible, its length equal to head posterior of the middle of the pupil.

Mandible 1.5 in head, its anterior tip below nostril. Distinct teeth but no canines in jaws, palatines, pterygoids, and vomer. Gill-membranes not broadly connected. Gill-rakers twenty-three on the lower limb of the first arch, the longest 1.7 in eye. These are flat and the inner margin spinulate. Opercle smooth, its length 2.3 in head, its width 1.7 in its length. Origin of the dorsal midway between end of caudal vertebra and posterior margin of eye, its longest ray distinctly more than the base of the fin, being equal to head posterior to middle of eye. Origin of the ventral anterior to dorsal, being midway between origin of pectoral and base of the third anal ray. Origin of pectoral midway between base of ventral and posterior margin of pupil, its length equal to head posterior of the anterior margin of eye, its tip extending to ventrals. Origin of the anal under the fifth ray of dorsal, its base equal to distance from origin of dorsal to opercle. Caudal forked, the lower lobe the longest, its length more than head.

Color hyaline, a distinct silvery lateral stripe, equal to length of eye or more anteriorly.

M. C. Z. 17,986. Cal.: San Diego. Hassler Expedition. Twenty specimens.

M. C. Z. 17,987. Cal.: San Diego. Hassler Expedition. Twenty-three specimens.

M. C. Z. 17,988. Cal.: San Diego. Hassler Expedition. Thirteen specimens.

M. C. Z. 17,989. Cal.: San Diego. Hassler Expedition. Twenty-one specimens.

M. C. Z. 17,990. Cal.: San Diego. Hassler Expedition. Eight specimens.

M. C. Z. 17,991. Cal.: San Diego. Hassler Expedition. One specimen.

M. C. Z. 24,298. Cal. Alexander Agassiz. One specimen. Length 112 mm.

M. C. Z. 31,404. Mexico. Stanford University. Three specimens.

California, from Point Concepcion to Magdalena Bay. Common. A rather large fish, notable for its unusual number of anal rays.

Anchoviella mundeola (Gilbert and Pierson).

Stolephorus mundeolus Gilbert & Pierson, Bull. 47, U. S. N. M., 1898, **3**, p. 2812.

Head 4; depth 3.8; dorsal 13; anal 35; ventral 7. Scales thirty-six. The grooves on the distal end of the scale are complete but with a distinct notch in the center, the anterior half of the scale has some horizontal grooves and three

or four incomplete grooves. The scales are persistent. Ventral profile but little curved and moderately sharp on its edge but without scutes. Eye one half greater than the snout, its length 3.6 in head. Mouth large, with a conical projecting snout above it. The anterior tip of the under jaw is under nostril. Maxillary reaching to the anterior third of opercle, its length 1.3 in the head, its tip obliquely pointed, its outline almost straight, its lower border with fine teeth. Mandible ending below the anterior border of the opercle, its length 1.4 in the head, its greatest depth 5 in its length. Fine teeth in jaws, vomer, palatines, and hyoid. Gill-rakers twenty-two on the lower limb of the first arch, the longest slightly more than one half of eye. Posterior half of the gill-chamber rounded. Opercle smooth. Origin of the dorsal is midway between the end of the caudal vertebra and the posterior margin of the eye, the longest ray much greater than the base of the fin, being equal to the distance from tip of the snout to opercle. Origin of the ventral anterior to dorsal, being midway between the origin of the pectoral and the anal pore, its length equal to the distance from tip of the snout to the posterior margin of the eye. Origin of the anal under the sixth dorsal ray. Origin of the pectoral midway between the origin of the ventrals and the posterior margin of the pupil, its length equal to the head without the snout. Caudal forked, its length greater than head. No alar scales.

Color silvery.

This species is abundant about Panama; it may prove inseparable from *Anchoviella panamensis*, both species having the anal fin unusually long.

Anchoviella spinifera (Cuvier and Valenciennes).

Engraulis spinifer Cuvier & Valenciennes, Hist. nat. poiss., 1848, **21**, p. 39.

Head 4; depth 4.2; dorsal 16; anal 37; ventral 7. Vertebrae forty-three. Scales forty-one, caducous, the scale-grooves on the anterior half of the scale incomplete, on the distal portion they form seven to nine rows of net-work or eyes. Ventral profile moderately curved, the margin not very sharp. No scutes. Snout projecting, pointed, its length 1.3 in eye. The eye is 5 in head. Mouth large, the maxillary extending slightly beyond the distal end of the mandible, its length equal to head posterior of the anterior margin of eye. Mandible ending below the lower anterior margin of preopercle, its length 1.2 in head, its anterior end under nostril. Distinct teeth in jaws, palatines, vomer, and pterygoids. Gill-membrane not broadly united. Gill-rakers fifteen on the lower limb of the first arch, these are short, flat, the longest about equal to eye. Subopercle with a short triangular projection extending posterior to opercle, hence *spinifer*. Length of opercle 1.7 in head, its width 3.1 in its length. Triangle of cheeks prominent. Origin of dorsal midway between tip of snout and the anterior margin of the caudal peduncle, its longest ray distinctly more than the base of the fin. Origin of ventral anterior to dorsal,

midway between origin of pectoral and anal. Origin of pectoral midway between origin of ventral and eye, its length slightly more than head posterior of the eye. Origin of the anal is below the 8th dorsal ray, its base equal to distance from origin of the dorsal to the upper anterior margin of the preopercle. Caudal forks, its lower lobe the longest, about equal to head.

Color silvery, brownish above. The silver lateral band wide and poorly defined anteriorly, but becoming narrowed to width of one scale posteriorly where it is well defined. Tip of dorsal and margin of caudal dark.

M. C. Z. 31,558 (Orig. 17,982). Panama. One specimen. Length 170 mm.

M. C. Z. 31,559 (Orig. 18,016). Brazil: Cachoeira. Nathaniel Thayer Expedition. Fourteen specimens. Length 80–185 mm.

West Indies and Brazil, also taken at Panama. A strongly-marked species notable for its long anal fin.

This species, with *Anchoviella panamensis*, *Anchoviella mundeola*, and others with many-rayed anal are quite different from the type of Anchoviella, but we fail to find any sharp line of demarcation.

Amplova Jordan and Seale.

Copeia, 1925, no. 141, p. 31.

A name used at Nice for the common European Anchovy; evidently derived from the same root, Gr. Anchovia.

Type.— *Amplova balboae* Seale.

This genus is close to Anchoviella, differing in the form of the mouth, which approaches that of Clupea, the maxillary being short, rounded behind, its width about equal to that of pupil. Anal rays twenty-seven; gill-rakers twenty to twenty-five.

Three species, from Brazil and Panama.

Amplova jamesi, sp. nov.

Head 4; depth 6; dorsal 12; anal 22; ventral 7. Scale caducous, about thirty-eight in lateral series. The scale with three to four grooves from center to anterior margin and a complete groove through the center, also four complete grooves on the posterior half but no net-work of lines. Ventral profile about equal to dorsal, body moderately compressed, the ventral margin sharp but without scutes. Head short and rounded, the snout not projecting, the jaws being almost equal, the deep rounded snout is above the tip of the lower jaw. Eye 3.2 in head. Snout 1.7 in eye. Mouth small, the maxillary being shaped much as in Clupea, its width being almost equal to the pupil, its tip

distinctly anterior to mandibular joint, being but little posterior to hind margin of eye, its length 2 in head, its posterior margin rounded. Mandible inserted under the posterior margin of the preopercle, its length less than head posterior of eye. Teeth small, in jaws, vomer, palatines, and pterygoids. No canines. Gill-membranes not broadly united. Gill-rakers twenty on the lower limb of the first arch, the longest 2 in eye. They are slim, narrow, and pointed, spinulose on their inner margin. Opercle smooth, its length 2.3 in head, its width almost equal to its length, its greatest width being on its lower half. Posterior margin concave. The subopercle is quadrangular in shape and forms the most posterior portion of the head, at the point where it joins the opercle. V of cheeks not evident. Origin of the dorsal midway between the caudal vertebra and the middle of the opercle, its longest ray almost twice the base of the fin, being equal to head behind the anterior margin of eye. Ventral anterior to dorsal, being midway between the origin of the pectoral and origin of anal, its length 2 in head. Origin of pectoral midway between ventrals and the anterior margin of eye, its length equal to dorsal, its tip reaching to ventrals. Origin of the anal is below the fifth dorsal ray, its base 4.2 in the standard length. Caudal forked, its length about equal to head.

Color light brownish, a rather indistinct silvery lateral stripe from head to caudal, its margin rather diffuse, its width less than eye.

TYPE.— M. C. Z. 18,014. Brazil: Jutahy River. William James. One specimen.

M. C. Z. 17,783. Brazil: Lago Alexo. S. V. R. Thayer. One specimen.

M. C. Z. 17,784. Brazil: Lago Alexo. S. V. R. Thayer. One specimen.

AMPLOVA BALBOAE, nom. nov.

Anchovia brevirostra Meek & Hildebrand, Fishes of Panama, 1923, p. 198.

This species lately described from Balboa in the Canal Zone is the original type of Amplova, having the same small herring-like mouth. It is, however, much deeper in body than *Amplova jamesi*, the depth $3\frac{1}{2}$ to 4; the anal rays twenty-three to twenty-seven; the gill-rakers twenty-five to thirty. The snout is very short, scarcely longer than pupil, and the maxillary does not reach posterior edge of eye. The caudal is edged with black.

Engraulis brevirostris Günther from Cachoeira, Bahia, Brazil, seems to belong to this same genus, being near *Amplova jamesi*. The name of the present species must therefore be changed.

Anchovia Jordan and Evermann.

Bull. 47, U. S. N. M., 1896, **1**, p. 449.

Type.— *Engraulis macrolepidota* Kner & Steindachner.

This genus is distinguished by the numerous, close set gill-rakers, there being ninety-five to one hundred and twenty on the lower limb of the first arch. The body is very deep and compressed, not translucent. Vertebrae forty to forty-two. No ventral scutes. Scales firm. Maxillary not extending posterior to the gill-openings. Origin of anal below anterior third of dorsal. Teeth fine, even. Tip of pectorals reaching to beyond base of ventrals. Silvery stripe, if present, broad and diffuse.

Several species in tropical America, among the largest of anchovies, deep-bodied and with very many long gill-rakers.

Anchovia clupeoides (Swainson).

Engraulis clupeoides Swainson, Nat. hist., 1839, **2**, p. 388.
Engraulis productus Poey, Repertorio, 1866, **1**, p. 380.
Stolephorus surinamensis Bleeker, Nat. tijd. dierk., 1866, **3**, p. 178.

Head 3.6; depth 3.6; dorsal 15; anal 30; ventral 7. Vertebrae forty. Scales forty, the grooves incomplete, the radii forming a net-work pattern of lines, two or three rows deep on the apical portion of scale. Ventral profile moderately curved, the margin somewhat compressed but not sharp. No scutes. Eye 4.5 in head. Snout pointed, projecting, its length half that of eye. Maxillary extending slightly posterior to mandible, but falling short of gill-openings, its length equal to head posterior of the eye, its anterior tip below the nostril. Small but perfectly formed teeth on vomer, palatines, and jaws, those on the edge of the maxillary very fine. Gill-rakers one hundred and two on the lower limb of the first arch, the longest equal to the distance from tip of snout to middle of eye, these are slim, pointed, and spinulose on their inner margin. Opercle smooth, its length 1.8 in head, its width 3 in its length. Subopercle with a projecting point, which, however, is much less distinct than in *Anchoviella spinifera*. Origin of the dorsal is midway between end of caudal vertebra and middle of eye. Origin of the ventral anterior to dorsal, being nearer to origin of the pectoral than to the anal, its length equal to the distance from the tip of snout to posterior margin of the eye. Origin of the pectoral midway between anal pore and the middle of the eye, its length equal to head posterior of the eye. Origin of the anal is under the 7th dorsal ray, the length of its base is 3.1 in the standard length. Caudal forked, its length equal to head.

Color silvery. No silvery lateral stripe on the type.

M. C. Z. 17,951. Cuba. Poey Coll. Two specimens. Length 160, 165 mm.

M. C. Z. 17,961. Cuba. Poey Coll. Two specimens. Length 160, 175 mm. COTYPES of *A. producta* (Poey).

M. C. Z. 17,964. Cuba. Poey Coll. One specimen. Length 160 mm.

M. C. Z. 18,010. Brazil: Pernambuco. Hart and Copeland. Three specimens.

M. C. Z. 28,822. Porto Rico: Palo Seco. Coll. Fish Hawk. One specimen. Length 133 mm.

M. C. Z. 31,556 (Orig. 22095). Brazil. Stanford University. Two specimens.

Abundant from Cuba to Brazil.

Largest of the Anchovies, reaching the length of a foot.

ANCHOVIA NATTERERI (Steindachner).

Engraulis nattereri Steindachner, Sitzber. Akad. wiss. Wien, 1880, **80**, p. 174.

Head 3.5; depth 3.3; dorsal 15; anal 33; ventral 7. Vertebrae forty-two. Scales forty, caducous, the grooves incomplete anteriorly, a net-work of lines on the posterior portion. Body deep and compressed, the ventral profile moderately curved, the margin compressed, but without scutes. Eye 4 in head. Snout pointed, projecting, its length 2 in eye. Mouth large, the maxillary ending at the mandibular joint and not extending posterior of the mandible, its length equal to head posterior of the pupil, its tip obliquely truncate. Mandible ending below the anterior margin of the preopercle, its length equal to the maxillary. Teeth apparently absent; a lens, however, reveals their presence in the jaws, vomer, palatines, pterygoids, and hyoids. Gill-rakers ninety-eight on the lower limb of the first arch, the longest equal to eye, these are slim, pointed, with their inner margin spinulose. No broad membrane on their inner margin. Opercle 1.8 in head, its width 3.5 in its length. Its surface smooth except a low rounded ridge in the center. Subopereulum with a point extending back (as in *Anchoviella spinifera* and *Anchovia clupeoides*). V of the cheeks distinct, its depth 2.5 in head. Origin of the dorsal midway between the end of the vertebra and posterior margin of the pupil, its longest ray slightly more than the base of the fin, but distinctly less than the head posterior of the eyes. Origin of the ventral posterior to dorsal, being nearer to origin of the pectoral than to anal, its length more than eye, broken in type. Origin of the pectoral midway between origin of the anal and the tip of snout, being much nearer to ventral than to eye, its length less than head posterior of the eyes, its tip reaching to ventrals. Origin of the anal is

below the 4–7 dorsal ray, its base 3.2 in the standard length. Caudal forked, its length less than head.

Color silvery, slightly darker above, no silvery lateral stripe.

M. C. Z. 18,044. Brazil: Parà. Nathaniel Thayer Expedition. Five specimens. Length 95–135 mm.

This species resembles *A. clupeoides* more nearly than it does Steindachner's description of *A. nattereri*. There is very little, if any, difference between the two.

Cetengraulis Günther.

Cat., 1868, **7**, p. 383.

Type.— *Engraulis edentulus* Cuvier.

This genus differs from all other members of the family in having the gill-membranes broadly united over the isthmus. These membranes are thin and readily torn, a fact which has caused confusion among the nominal species. Vertebrae forty-one. Body elongate, compressed, rather deep. No armed scutes on ventral margin. Maxillary short, not extending beyond base of mandible. Teeth very minute. Gill-rakers fine, numerous, fifty to fifty-seven, with a broad membrane lining their inner surface. Origin of anal under posterior third of dorsal, its rays twenty-three to twenty-six. No silvery lateral stripe.

The two known species are from tropical America.

Cetengraulis edentulus (Cuvier).

Engraulis edentulus Cuvier, Règne anim., ed. 2, 1829, **3**, p. 323.
Cetengraulis edentulus Günther, Cat., 1868, p. 383. Cuvier & Valenciennes, Hist. nat. poiss., 1848, **21**, p. 51. Meek & Hildebrand, Fishes of Panama, 1923, p. 214.
Engraulis brevis Poey, Repertorio, 1866, **1**, p. 379.
Stolephorus garmani Evermann & Marsh, Rept. U. S. fish. for 1899, 1900, p. 352. Separate: Washington, 1900, p. 89.
Stolephorus gilberti Evermann & Marsh, Rept. U. S. fish. for 1899, 1900, p. 352. Separate: Washington, 1900, p. 90.

Head 3.3; depth 3; dorsal 15; anal 23 to 25; ventral 7. Vertebrae forty-one. Last ray of the anal and also of the dorsal is slightly longer than the middle rays. Each ventral is almost concealed beneath a large scale. Dorsal and anal with very deep scaly sheaths. Scales thirty-nine, not caducous, the grooves incomplete forming numerous angles on the anterior half of the scale and about eight rows of graduated net-work on the posterior half. Ventral

profile not strongly curved, the margin rather dull, without scutes. Snout projecting, pointed, its length 1.7 in eye. The eye is 4.5 in head. Mouth large, the maxillary falling a trifle short of the end of the mandible, its length equal to head posterior of the eye. Mandible 1.7 in head, its posterior margin on a line with preopercle. Fine teeth in the jaw and vomer, palatines, and pterygoids. Gill-membranes broadly united across the isthmus, unless torn apart. Gill-rakers fifty-two on the lower limb of the anterior arch. The rakers are long, slim, the longest equal to the distance from tip of snout to hind margin of pupil. There is a deep gill-membrane on the inside of each gill-arch. Each gill-raker is strongly bent or rather branched, one branch forming the true raker and the other a false raker buried in membrane just inside of the true raker, being more or less V-shaped in section. Opercle smooth, its length 1.7 in head, its width 2.1 in its length, its lower margin strongly oblique. Origin of the dorsal midway between the end of the caudal vertebra and the posterior margin of eye, its longest ray scarcely equal to the base of the fin, being less than head posterior of eyes. Origin of the ventral anterior to dorsal, being midway between pectoral and anal bases, its length equal to the distance from tip of the snout to posterior margin of the pupil. Origin of the pectoral midway between ventrals and the posterior margin of the eye, its length less than head posterior of the eye; a third of the fin is covered with scales. Origin of the anal is under the 12th dorsal ray, its base equal to head posterior to the middle of eye. Caudal forked, length less than head. Alar scales present.

Color yellowish bronze, no trace of silver lateral stripe.

M. C. Z. 4,694. Brazil: Rio de Janeiro. Nathaniel Thayer Expedition. Twenty-four specimens. Length 115–165 mm.

M. C. Z. 17,957. Cuba: Poey Coll. Two specimens. Length 150, 155 mm.

M. C. Z. 17,960. Cuba. Poey coll. One specimen. Length 140 mm.

M. C. Z. 17,962. Cuba. Poey Coll. One specimen. Length 130 mm.

M. C. Z. 18,058. Brazil: Sambaia. Nathaniel Thayer Expedition. Two specimens.

M. C. Z. 18,059. Brazil: Cachoeira. Nathaniel Thayer Expedition. One specimen. Length 130 mm.

M. C. Z. 24,296. Cuba. Poey Coll. One specimen. Length 128 mm. (TYPE of *Engraulis brevis* Poey. Head 3.1; depth 3.1; maxillarly equal to postorbital part of head; gill-rakers 57).

M. C. Z. 31,451. Brazil: Rio de Janeiro. One specimen.

M. C. Z. 31,557 (Orig. 17,951a). Cuba. Poey Coll. Two specimens. Length 150, 155 mm.

Atlantic coasts of tropical America.

According to Meek and Hildebrand who have examined the types of both, *Stolephorus garmani* and *Stolephorus gilberti* are both identical with *Cetengraulis edentulus*, the weak membrane of the branchiostegal having in both cases been torn.

Cetengraulis mysticetus (Günther).

Engraulis mysticetus Günther, Proc. Zool. soc. London, 1866, p. 604.
Cetengraulis mysticetus Günther, Cat. 1868, **7**, p. 383.
Stolephorus opercularis Jordan & Gilbert, Proc. U. S. N. M., 1882, **4**, p. 275.

Head 2.5; depth 3.2; dorsal 15; anal 23; ventral 7. Vertebrae eighty-one. The last anal and last dorsal a trifle longer than the middle rays of these fins. Scales forty-one; the grooves incomplete, the posterior half of the scale with about eight rows of net-work which are graduated. Ventral profile moderately rounded, more rounded than dorsal, its margin compressed but not sharp. No scutes. Snout projecting, pointed, its length 1.5 in eye. The eye is 5.1 in head. Mouth large, the maxillary 1.7 in head, its posterior end not quite reaching distal end of the mandible, its length being less than head posterior of eye. Mandible 1.7 in head, its anterior tip under the nostril, its posterior end under the lower anterior border of the preopercle. Some very small teeth present in jaws, palantines, and hyoid. Gill-membranes broadly united, gill-rakers fifty-seven on the lower limb of the first arch. These are long, slim, with a broad membrane on the inner side (as described for *Cetengraulis edentulus*). Longest gill-raker equal to the distance from tip of snout to posterior margin of pupil. Opercle smooth, its length 2 in head, its width 2 in its length. Origin of the dorsal midway between end of the caudal vertebra and anterior margin of the preopercle, its longest ray equal to the base of the fin. Origin of ventral but little anterior to dorsal, its length equal to distance from tip of snout to posterior margin of the pupil. Origin of the pectoral much nearer the ventrals than to eye, its length distinctly less than the postorbital portion of head. Origin of the anal under the 12th ray of dorsal, its base less than the postorbital portion of head. Caudal forked equal to postorbital of head. Alar scales distinct.

Color silvery, darker above, no silvery lateral stripe on our specimens, tip of caudal a little dark.

M. C. Z. 18,055. Panama. Hassler Expedition. Three specimens. Length 137–150 mm. (These specimens differ from *C. edentulus* chiefly in the longer and more pointed head).

M. C. Z. 18,056. ————. Hassler Expedition. Eight specimens. Length 140–155 mm.

Pacific Coast of tropical America.

Cetengraulis engymen Gilbert and Pierson from Panama is said to

have the gill-membranes narrower, the gill-rakers thirty, the anal rays twenty to twenty-three. Meek and Hildebrand regard this species as identical with *C. mysticetus*, but the gill-rakers are much fewer in number. *Stolephorus opercularis* they consider the same, the branchiostegal membrane in the type being evidently torn.

Medipellona, gen. nov.

Type.— *Pellona bleekeriana* Poey.

This genus, based on a very rare Cuban species, shows some traits intermediate between Ilisha of the Clupeidae, and the Engraulidae. There are teeth on vomer as well as on palatines and pterygoids and some of them canines. Maxillary firmly joined to premaxillary; lower jaw projecting; snout broad, deeply notched; ventral fin very small; origin of dorsal behind front of anal. Vertebrae forty-three; anal fin long, of forty-three rays. Gill-rakers few.

Medipellona bleekeriana (Poey).

Pellona bleekeriana Poey, Repertorio, 1867, **2**, p. 242.
Ilisha bleekeriana Jordan & Evermann, Bull. 47, U. S. N. M., 1896, **1**, p. 436.

Body elongate, compressed, not deep, the ventral profile but little curved, its margin sharp and armed with distinct scutes from head to anal pore. Vertebrae forty-three. Scales caducous. Maxillary prolonged, wide, its width equal to two thirds of eye, its length 1.2 in head, tapering to a sharp point posterior of the mandible. Mandible short, deep, shaped as in Clupea, its greatest depth being on its anterior third and about 2 in its length. Teeth distinct in jaws, vomer, palatines, and pterygoids, those of the maxillary, strong canines, intermixed with numerous small teeth. Two to four canines in the front of each jaw; maxillary firmly united to premaxillary; two supplemental bones present. Gill-membranes not broadly united over isthmus. Gill-rakers about fifteen on lower limb of first arch. Origin of dorsal behind origin of anal. Ventrals very small, less than eye, and located midway between end of vertebrae and postorbital, its base 2.5 in standard length. Opercle smooth except a short ridge ending in a buried spine on upper anterior portion. Caudal forked. Depth $5\frac{2}{3}$ with caudal. D. 15; A. 43; Scutes twenty-five (*Poey*).

Poey's types of *Pellona bleekeriana* from which the above account is taken exhibits relationship to both Ilisha (Pellona) and the engraulids. The presence of distinct teeth on the vomer and the maxillary firmly joined to the premaxillary separates it at once from Ilisha. Its short

deep under jaw and wide maxillary, projecting under jaw, and the broad, thin, short snout with its deep notch is not at all like the engraulids. The arrangement of the fins, however, and the teeth, also the presence of the silvery lateral stripe indicates a close relationship to that group, and the junior author believes that Medipellona is as closely related to the Engraulidae as to Ilisha in which genus it has been placed by Jordan and Evermann. In the judgement of the senior author, its relationships are on the whole nearer Ilisha, a matter worthy of investigation as perhaps indicating the point of union of Clupeidae and Engraulidae.

Medipellona caribbea (Meek and Hildebrand).

Ilisha caribaea Meek & Hildebrand, Fishes of Panama, 1923, p. 191, fig. 1.

Besides *Medipellona bleekeriana*, a second species not very different has been lately described from Panama. It has the head $4\frac{2}{5}$ in length, the depth $5\frac{1}{2}$. Anal rays thirty-seven or thirty-eight. Gill-rakers sixteen. Ventrals shorter than eye. Dorsal beginning slightly behind front of anal.

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LXVII. No. 12.

A COLLECTION OF BIRDS FROM SOUTHWESTERN NEW GUINEA (MERAUKE COAST AND INLAND).

By Outram Bangs and James L. Peters.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
July, 1926.

No. 12.— *A Collection of Birds from southwestern New Guinea (Merauke coast and inland).*

By Outram Bangs and James L. Peters.

This collection, a recent gift to the M. C. Z. by Dr. Thomas Barbour, was made by Thomas Jackson in 1920–1924, in the general region of Merauke, Dutch New Guinea.

This region, opposite Cape York, is an interesting part of Papua as it has a strong Australian element in its bird-fauna. Several of the forms have apparently not been taken previously in New Guinea and others have been recorded from Merauke only by Van Oort (Nova Guinea, 1909).

Unfortunately Jackson's collection contains very few small birds, and gives an impression that bird collecting was far from being a primary consideration with him. His labels, written on paper of very poor quality, twisted about the leg, and sometimes from dampness or some such cause disintegrated entirely, left the specimen with only a fragment of paper on the leg. Such specimens are listed "no data." There were no field-notes accompanying the collection, except that a few labels have notations such as "very common," "very scarce," "legs black" and sometimes the total length is given in inches. Neither is there any itinerary. The spelling of geographic names on the labels does not always coincide with those on current maps; for instance Mapi is written "Mapia"; "Ellinder" River we take to be Eilenden; "Edrich" Edric; and "Myjoie" River we have been unable to interpret, though judging from the dates of collection, it is doubtless a tributary of the Upper Digul; the "Wendoe Mer" River probably is near Merauke.

In the case of some of the species we were unable to determine definitely the subspecies owing to altogether inadequate material from Australia, particularly from Northwest Territory and Cape York. These Dr. Ernst Hartert most kindly compared at Tring, where the Mathews Collection is, and has sent very full notes on his results. Without this generous coöperation it would have been impossible to settle a number of cases.

CASUARIUS CASUARIUS SCLATERI Salvadori.

One. Adult; no data.

MEGAPODIUS REINWARDT DUPERREYI Lesson and Garnot.

Two. One, ♀; Mapi River, 3 October, 1923; one, sex?; Merauke River.

PTILOPODISCUS CORONULATUS (Gray).

One. No data.

CHLOROTRERON IOZONA IOZONA (Gray).

Three. Two, ♂♂; Merauke, 23 March, 1924; one, no data.

SYLPHITRERON AURANTIIFRONS (Gray).

One. ♀; no farther data.

SYLPHITRERON PERLATA ZONURA (Salvadori).

One. ♀; Upper Digul River, 27 August, 1923.

MEGALOPREPIA MAGNIFICA POLIURA Salvadori.

Two. ♂♀; Edrich River, 18, 22 September, 1923.

MUSCADIVORES ZOEAE (Lesson).

Two. One, ♂; Mapi River, 10 October, 1923; one, sex?; Edrich River, 10 September, 1923.

ZONOPHAPS RUFIGASTER (Quoy and Gaimard).

Two. ♂♂; one, Mapi River, 1 October, 1923; one, Edrich River, 13 September, 1923.

CARPOPHAGA MÜLLERI MÜLLERI (Temminck).

One. ♀; Lower Digul River, 12 September, 1923.

CARPOPHAGA PINON PINON (Quoy and Gaimard).

Three. ♀♀; two, Princess Marianne Strait, 12, 28 November, 1923; one, Edrich River, 6 September, 1923.

MACROPYGIA AMBOINENSIS CINEREICEPS Tristram.

Two. Sex ??; one, Edrich River, 23 September, 1923; one, no data.

REINWARTOENAS REINWARDTI GRISEITINCTA Hartert.

Two. One, ♀; Mapi River, 7 October, 1923; one, sex?; Edrich River, 15 September, 1923.

GEOPELIA HUMERALIS GREGALIS, subsp. nov.

Three. One, ♂; Wendoe Mer River, 19 April, 1924; two, no data.

TYPE. M. C. Z. 99,488. Adult ♂. Southwest New Guinea: Wendoe Mer River. 19 April, 1924. Thomas Jackson.

Characters. Similar to *Geopelia humeralis humeralis* (Temminck) but darker above, especially the hind neck which is nearly Mikado-brown instead of vinaceous-cinnamon or orange-cinnamon.

Measurements.

No.	*Sex*	*Wing*	*Tail*	*Tarsus*	*Culmen to base of forehead*
99,488	♂ ad.	135	142	25.5	20.5
99,489	ad.	134	141	24.	21.5
99,490	ad.	125	124	22.	20.

Unable to make any decision as to the races of *humeralis* from Mathews's account in the Birds of Australia, these specimens were referred to Dr. Hartert for comparison with adequate Australian material.

HENICOPHAPS ALBIFRONS Gray.

Two. One, ♂; Mapi River, 6 October, 1923; one, ♀; Lower Digul River, 12 September, 1923.

HYPOTAENIDIA PHILIPPINENSIS YORKI Mathews.

Two adults; no data.

Measurements.

No.	*Wing*	*Tail*	*Tarsus*	*Culmen to base of forehead*
99,491	128	58	35	29.
99,492	130	56	35	31.5

Dr. Hartert has kindly compared these two skins with the series at Tring, which now includes the Mathews Collection, and writes that they agree with *H. p. yorki* which inhabits Cape York and northern Queensland at least to Cairns; it is a smaller bird than the other Australian forms.

Van Oort (Nova Guinea, 1909, p. 57) recorded two specimens from Merauke as *Hypotaenidia philippensis* (Linné).

MEGACREX INEPTA D'Albertis and Salvadori.

One. ♂; Lower Digul River, 11 September, 1923.
Noted on the label as "very scarce."

PORPHYRIO MELANOPTERUS MELANOPTERUS Bonaparte.

One. Adult, sex ?; Merauke Swamp, 12 January, 1923.

POLIOCEPHALUS RUFICOLLIS NOVAE-HOLLANDIAE (Stephen).

Four. Sex ?; one, Eilenden River, May, 1920; three, Merauke Swamp, 9 January, 1923.

IREDIPARUS GALLINACEUS NOVAE-GUINEAE (Ramsay).

One. Sex ?; Merauke Swamp, 1923.

THRESKIORNIS MOLUCCA MOLUCCA (Cuvier).

One. Sex ?; Merauke Swamp, 1923.

ARDEA SUMATRANA SUMATRANA Raffles.

Two. One, ♂ immature; Edrich River, 15 September, 1923; one, sex ?, immature; Merauke, 9 November, 1923.

MESOPHOYX INTERMEDIA PLUMIFERA (Gould).

Two. Sex ?; Princess Marianne Straits, 8 November, 1923.

DEMIGRETTA SACRA (Gmelin).

One. ♂; "D. I. W. St.," [Deliverance Island], 2 May, 1924.
We agree with Hartert, that it is impossible to recognize any races of

the Reef Heron, and that all color differences in this species are due solely to dichromatism. The single skin in the collection is that of a bird in the blue phase, apparently not fully adult.

NYCTICORAX CALEDONICUS CALEDONICUS (Gmelin).

Two. Sex ?; one, Java Creek, 28 April, 1924; one, Merauke Swamp.

BUTORIDES STRIATUS MACRORHYNCHUS (Gould).

One. Adult ♂; Merauke River, 12 April, 1923.

We have followed Hartert in his review of the races of *Butorides striatus* (Vögel paläarktischen fauna, 1920, **2**, heft. 10, p. 1250–1251) in referring this skin to *macrorhynchus*.

ANSERANAS SEMIPALMATA (Latham).

Two. ♂, ♀; near Merauke, 1923.

DENDROCYGNA GUTTULATA Wallace.

Three. One, ♂; Mapi River, 30 September, 1922; two, sex ?; near Merauke, 14 April, 1924.

TADORNA RADJAH RADJAH (Garnot).

Three. One, ♀; two, sex ?; Princess Marianne Straits, 12 October, 1923.

PHALACROCORAX MELANOLEUCUS MELANOLEUCUS (Vieillot).

Two. One, ♂; Merauke, 14 March, 1924; one, sex ?; Merauke, 1923.

ANHINGA RUFA NOVAE-HOLLANDIAE Gould.

Two. One, ♀; Edrich River, 11 September, 1923; one, sex ?; Eilenden River, May, 1921.

ASTUR HIOGASTER ETORQUES Salvadori.

One. ♂ immature; Princess Marianne Straits, 6 November, 1923.

Measurements.—Wing, 210; tail, 159; tarsus, 60; middle toe, 32; culmen to cere, 17.5.

Haliastur indus leucosternus (Gould).

One. ♀; Princess Marianne Straits, 4 November, 1923.

Haliastur sphenurus sphenurus (Vieillot).

Four. One, ♂; one, ♀; Princess Marianne Straits, 2 November, 16 December, 1923; one, ♀; Merauke, 15 March, 1924; one, sex ?; Merauke, May, 1923.

Henicopernis longicauda (Garnot).

One. Sex ?; Upper Digul River, June, 1922.

Ninox humeralis Bonaparte.

One. Sex ?; Upper Digul River, 4 December, 1923.

Chalcopsittacus scintillatus (Temminck).

Two. One, ♂; Princess Marianne Straits, 25 January, 1924; one, ♀; Mapi River, 3 October, 1923.

Lorius lory erythrothorax Salvadori.

Three. One, ♂; Mapi River, 6 October, 1923; one, ♀; Edrich River, 21 September, 1923; one, sex ?; Upper Digul River, 21 June, 1922.

Trichoglossus nigrigularis Gray.

Four. Two, ♂♂, one, ♀; Princess Marianne Straits, 20 November, 1923, 22 January, 1924; one, ♂; Wendoe Mer River, 20 April, 1924.

Hypocharmosyna placentis (Temminck).

One. ♂; Princess Marianne Straits, 20 November, 1923.

Probosciger aterrimus goliath (Kuhl).

Four. One, ♂, one, sex?; Wendoe Mer River, 5 April, 1924; two, sex ?; Lower Digul River, 26 September, 1923.

Measurements.

No.	*Sex*	*Wing*	*Tail*	*Culmen*
99,547	—	348	249	94
99,548	♂	359	247	72
99,549	—	370	242	101
99,550	—	334	245	69

Dr. Hartert writes that he considers that there are but two forms of the Black Cockatoo on the main island of Papua — *P. a. stenolophus* Van Oort, with narrow creast feathers, north coast from Humboldt to northernmost British Papua, and *P. a. goliath* (Kuhl) with wide creast feathers, Beráu, Onin peninsula, and foot of Snow Mountains to southeast Papua.

The Cape York form *P. a. aterrimus* (Gmelin) (of which *macgillivrayi* Mathews is a synonym) is a very much blacker bird.

Cacatua galerita triton (Temminck).

Two. ♂♂; Wendoe Mer River, 4 April, 1924; Edrich River, 11 September, 1923.

Electus pectoralis (Müller).

Six. Sex ?; Lower Digul River, April, 1923, 24 September, 1923; Upper Digul River, 11 August, 1923; Princess Marianne Straits, 21 November, 1923.

Geoffroyus aruensis (Gray).

Two. One, ♂; Upper Myjoie River, 29 August, 1923; one, sex ?; "shot on the coast," 2 November, 1923.

Aprosmictus erythropterus coccineopterus (Gould).

Three. One, ♂, one, ♀ ?; Princess Marianne Straits, 14 January, 1923, 14 November, 1923; one, ♂; Wendoe Mer River, 2 April, 1924.

Noted as "very common" on the label of one skin.

Neither of the males is quite fully adult, both having dark green feathers mixed in with the black of the back.

Measurements.

No.	*Sex*	*Wing*	*Tail*	*Culmen to cere*
99,561	♂	190	128	18
99,562	—	185	137	19
99,563	♂	175	130	18

Dr. Hartert very kindly compared these skins with the series at Tring and states that they differ in no wise from examples from the Northern Territory of Australia and from Cape York. He considers *yorki* Mathews a synonym of *coccincopterus* Gould. True *A. c. erythropterus* (Gmelin) of New South Wales and southern Queensland is a larger bird.

Van Oort mentions one example from Merauke, the first authentic record of this parrot in Papua.

Podargus papuensis Quoy and Gaimard.

One. ♂; Wendoe Mer River, 3 April, 1924.

Eurystomus crassirostris Sclater.

Six. One, ♂ and one, sex ?; Merauke, 23 March, 1924; one, ♀; Lower Digul River, 24 September, 1923; one, ♂ and two, sex ?; Merauke River, 4 April, 1924.

Alcyone azurea lessoni Cassin.

Two. One, ♂ and one, sex ?; Upper Myjoie River, 6 August, 1923.

Syma torotoro meeki Rothschild and Hartert.

One. ♀; Princess Marianne Straits, 16 November, 1923.

Dacelo leachii intermedia Salvadori.

Three. One, ♂; Wendoe Mer River, 3 April, 1924; one, ♂, one, ♀; Merauke, 23 March, 1924.

Sauromarptis gaudichaudi (Quoy and Gaimard).

Four. One, ♂; Princess Marianne Straits, 6 November, 1923; two, sex ?; Edrich River, 11, 16 September, 1923; one, no data.

Halcyon macleayii Jardine and Selby.

Two. ♂, and sex ?; Princess Marianne Straits, 20 November, 1923.

Halcyon nigrocyanea Wallace.

One. ♂; Princess Marianne Straits, 17 December, 1923.

HALCYON SANCTUS Vigors and Horsfield.

One. No data.

TANYSIPTERA HYDROCHARIS MICRORHYNCHA Sharpe.

Four. One, ♂; Lower Digul River, 20 September, 1923; two, ♂♂, one sex ?; Princess Marianne Straits, 9, 17 November, 1923, 9 January, 1924.

RHYTIDOCEROS PLICATUS (Forster).

Five. Three, ♂♀♀; Lower Digul River, 15, 24, 28 September, 1923; one, ♂; Edrich River, 28 September, 1923; one, ♂; Wendoe Mer River, 6 April, 1924.

MEROPS PHILIPPINUS SALVADORII Meyer.

Two. ♂♂; Princess Marianne Straits, 2, 15 November, 1923.

MEROPS ORNATUS Latham.

One. No data.

EUDYNAMIS SCOLOPACEUS RUFIVENTER (Lesson).

One. Sex ?; Lower Digul River, 17 September, 1923.

SCYTHROPS NOVAE-HOLLANDIAE Latham.

Three. ♂♂, and sex ?; Wendoe Mer River, 4, 7, 8 April, 1924.

CENTROPUS NIGRICANS Salvadori.

Four. One, ♀; Princess Marianne Straits, 4 November, 1923; three, sex ?; Merauke, 11 January, 1923.

PITTA MACKLOTI MACKLOTI Temminck.

Two. One, ♂; Lower Digul River, 28 September, 1923; one, ♀; Edrich River, 22 September, 1923.

RHIPIDURA RUFIVENTRIS GULARIS Müller.

One. No data.

ARSES TELESCOPHTHALMUS HENKEI Meyer.

One. ♂; Lower Digul River, 12 September, 1923.

MONARCHA ALECTO CHALYBEOCEPHALUS (Garnot).

One. ♂; Upper Myjoie River, 1 August, 1923.

ARTAMIDES CAERULEIGRISEUS (Gray).

One. Sex ?; Upper Digul River, May, 1922.

POMATORHINUS TEMPORALIS CORNWALLI Mathews.

Three. One, ♂; Wendoe Mer River, 9 April, 1924; two, ♂, ♀; Princess Marianne Straits, 2, 15 November, 1923.

Measurements.

No.	*Sex*	*Wing*	*Tail*	*Tarsus*	*Culmen to base*
99,603	♂	116	116	36	35
99,604	♀	110	100	35	31
99,605	♂	113	116	37	32

These specimens were compared by Dr. Hartert with the large series at Tring and were found to be wholly referable to the small form which inhabits Cape York and northern Queensland.

ARTAMUS CINEREUS VENUSTUS Sharpe?

One. ♀; Princess Marianne Straits, 6 November, 1923.

The identity of the single Wood Swallow in the collection (M. C. Z. 99,606) is most puzzling. Apparently it is more closely allied to *venustus* than to any other form, since it lacks any trace of black across the forehead, has no white tips to the central rectrices, and the under tail-coverts are white except at the extreme base. It, however, has very little black on the chin — much less than in most of the Australian specimens — in this respect approaching typical *cinereus* from Timor. On the other hand the specimen is small:— wing, 112; tail, 69; tarsus, 20; culmen to base, 21.5.

Dr. Hartert has examined the skin and considers that, awaiting more specimens, it had better be referred provisionally to *venustus*.

PITOHUI FERRUGINEUS FERRUGINEUS (Bonaparte).

Two. One, ♂; Princess Marianne Straits, 2 November, 1923; one, sex ?; Mapi River, 7 October, 1923.

COLLURICINCLA HARMONICA TACHYCRYPTA Rothschild and Hartert.

One. ♂; "shot on the coast," 27 April, 1924.

Measurements.— 99,609 M. C. Z. Wing, 119; tail, 96; tarsus, 31; culmen to base, 27.

This skin was compared with the material at Tring by Dr. Hartert, who finds that it is quite the same as *tachycrypta*, type from Milne Bay. *C. h. superciliosa* Masters from Cape York, though otherwise much like *tachycrypta*, has a much longer wing and shorter, thicker bill.

GYMNORHINA TIBICEN PAPUANA, subsp. nov.

TYPE.— M. C. Z. 99,653. Adult ♀. Southwest New Guinea: Princess Marianne Straits, 12 November, 1923. Thomas Jackson.

Characters.— Similar to *Gymnorhina tibicen longirostris* Milligan, but white nuchal patch much narrower; bill stouter anteriorly and less tapering. Tibiae white, the feathers blackish only at the base.

Measurements.— Wing, 245; tail, 137; tarsus, 64; culmen to base, 63. Terminal black band on tail, 60.

H. L. White has recently (Emu, 1922, **21**, p. 163) described *G. t. eylandtensis* from Groote, Eyland, Northern Territory of Australia, which differs in having mottled tibiae, a wing of only 220 mm. and the terminal black band on the tail reduced to 30 mm. in width.

CRACTICUS QUOYI QUOYI (Lesson).

Two. One, ♂, one, ♀; Princess Marianne Straits, 6, 19 November, 1923.

CRACTICUS CASSICUS (Boddaert).

One. ♂ immature; Upper Myjoie River, 1 August, 1923.

CRACTICUS MENTALIS Salvadori and D'Albertis.

One. ♂; Merauke River, 1 April, 1924.

Pachycephala pectoralis melanura Gould.

One. [♀]; no data.

Zosterops albiventris Hombron and Jacquinot.

One. ♂; Deliverance Island, 3 May, 1924.

Measurements.— M. C. Z. 99,612. Wing, 59; tail, 41; tarsus, 17; culmen to base, 14.

Zosterops albiventris was described from Warrior Island. At Tring there are no specimens from that island, and only two, the types of *cairncrossi*, from Cairncross Island. Compared with these Dr. Hartert found our bird to agree very well in size and color, except that the flanks are a trifle more buffy, not so white, a difference that may well be individual.

The species according to Mathews is confined to the wooded islands of Torres Straits, and does not occur on the mainland (Birds of Australia, **11**, p. 162). *Zosterops flavigularis* Masters, which Mathews synonymizes with *Z. albiventris* was, however, described from Cape Grenville, northern Queensland.

Hermotimia sericeus sericeus (Lesson).

One. ♂; Upper Myjoie River, 18 August, 1923.

Myzomela fumata Bonaparte.

One. ♂; Princess Marianne Straits, 25 November, 1923.

Entomyzon cyanotis harterti Robinson and Laverock.

Entomiza cyanotis griseagularis Van Oort, Nova Guinea, 1909, **9**, p. 97, Merauke.

One. ♂; Wendoe Mer River, 6 April, 1924.

This specimen (M. C. Z. 99,615. Wing, 139; tail, 113; tarsus, 36; culmen to base, 30) which Dr. Hartert compared at Tring with four skins from Cooktown, among them the type of *harterti*, agrees perfectly.

When Van Oort described *griseagularis* he did so, apparently, without knowledge of *harterti*, comparing his bird only with *cyanotis*.

TROPIDORHYNCHUS NOVAE-GUINEAE BREVIPENNIS Rothschild and Hartert.

Two. One, ♀, one, sex ?; Princess Marianne Straits, 15 November, 1923, 22 January, 1924.

MIRAFRA HORSFIELDI PARVA Swinhoe.

One. No data.

This single skin (M. C. Z. 99,611) not sexed, is considerably smaller (wing, 65; tail, 41; tarsus, 22; culmen to base, 12.5) than most of the skins at Tring from Sumba, Lombok, etc. One female, however, from Sumba has the wing only two mm. longer than in our bird.

It is possible that more material may show that there is a small resident race in southeast New Guinea.

MINO DUMONTI ARUENSIS Stresemann.

Four. One, sex ?; Mapi River, 3 October, 1923; one, ♀, two, sex ?, Upper Myjoie River, 31 July, 29 August, 1923.

On the whole this series is best referred to this form.

MELANOPYRRHUS ANAIS ROBERTSONI D'Albertis.

Three. One, ♂, one, ♀, one, sex ?; Upper Myjoie River, 28, 29 August, 1923.

On geographical grounds these should be *robertsoni*, and one of them, M. C. Z. 99,630, on characters also fits that form very nicely. The other two, M. C. Z. 99,631, 99,632, however, with a good deal of black on the nape, approach *M. a. orientalis* (Schlegel).

APLONIS METALLICA METALLICA (Temminck).

Two. ♀ ♀; Lower Digul River, 17 September, 1923.

ORIOLUS FLAVOCINCTUS MÜLLERI (Bonaparte).

One. ♂ (topotype); Princess Marianne Straits, 19 November, 1923.

ORIOLUS SZALAYI (Madarász).

One. ♂, Princess Marianne Straits, 11 November, 1923.

Dicrurus bracteata ultramontanus Stresemann.

Four. One, ♂, one, ♀; Princess Marianne Straits, 11, 15 November, 1923; one, ♀, one, sex ?; Upper Myjoie River, 11 August, 1923.

Ptiloris magnifica magnifica (Vieillot).

Three. Two, ♂♂, one, sex ?; Mapi River, 18 September, 7, 8 October, 1923.

Seleucides ignotus (Forster).

One. ♂; Lower Digul River, 26 September, 1923.

Paradisaea apoda novae-guineae D'Albertis and Salvadori.

Three. One, ♂, one, ♀, one, sex ?; Upper Digul River, 1, 29, 30 August, 1923.

Cicinnurus regius claudii Ogilvie-Grant.

Two. One, ♂; Mapi River, 3 October, 1923; one, ♀; Lower Digul River, 26 September, 1923.

Phonygammus keraudreni keraudreni (Lesson and Garnier).

Three. Two, ♂♂; Upper Myjoie River, 28, 30 August, 1923; one, sex ?; Upper Digul River, 28 August, 1923.

Manucodia ater alter Rothschild and Hartert.

One. ♂; Princess Marianne Straits, 11 November, 1923.

Manucodia chalybatus orientalis Salvadori.

One. ♀; Upper Myjoie River, 31 July, 1923.

Corvus coronoides orru Bonaparte.

Two. One, ♂; Wendoe Mer River, 2 April, 1924; one, ♂; Princess Marianne Straits, 2 January, 1924.

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LXVII. No. 13.

FOSSIL INSECTS FROM THE LOWER PERMIAN OF KANSAS.

By Frank M. Carpenter.

With Three Plates.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
July, 1926.

No. 13.— *Fossil Insects from the Lower Permian of Kansas.*

By Frank M. Carpenter.

During the latter part of the summer of 1925, I accompanied Prof. P. E. Raymond on a brief expedition of the Museum of Comparative Zoölogy to the Permian insect deposit in Elmo (Banner Township), Kansas. Up to the present time over 4,000 specimens of insects, representing a fauna quite distinct from that of other Permian beds, have been collected by various students at this locality. Ten orders (Palaeodictyoptera, Protorthoptera, Blattaria, Protodonata, Odonata, Plectoptera, Protohymenoptera, Mecoptera, Copeognatha and Homoptera) have already been recognized by Sellards and Tillyard; Dr. Tillyard, who is working on the Yale collection, has indicated several others which have not yet been described. Most of the specimens collected from these rocks are remarkably well preserved, as shown by the illustrations accompanying Tillyard's descriptions, and by those contained in this paper, and this adds greatly to the value of the fossils, since the period to which the deposit belongs is one of the least understood in the whole geological history of insects. Four of the orders mentioned above are represented by well-preserved specimens in the thirty-three fossils forming the M. C. Z. collection, which although comparatively small is fairly representative.

To Professor Raymond, whose interest and encouragement has made possible this opportunity to work on fossil insects, I am especially grateful; and to the Museum authorities, I am also indebted, both for authorizing the expedition and for the privilege of studying the specimens. Prof. C. T. Brues has made many helpful suggestions, and Dr. R. J. Tillyard, during his recent visit to this country, was kind enough to examine and discuss with me the fossils.

Plectoptera. Protereismidae Handlirsch.

Rev. palaeoz. insekten, 1919, p. 63.

Protereismephemeridae Sellards, Amer. journ. sci., 1906, ser. 4, **23**, p. 345.

Twelve species of this family of archaic mayflies have been described by Sellards from the Kansan Permian. They are easily separated from the Ephemeridae by several characters, especially by the presence

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Twelve species of this family of archaic mayflies have been described by Sellards from the Kansan Permian. They are easily separated from the Ephemeridae by several characters, especially by the presence

of the costal brace, and by the absence of the tornus. Two specimens of the family are in the M. C. Z. collection. One of these (M. C. Z. 2,796, Plate **1**, fig. 1), consisting of a basal fragment of a wing, shows the costal brace, but is too incomplete to permit further determination. The other specimen (M. C. Z. 2,785a-b, Plate **1**, fig. 2) is a well-preserved apical half of a fore wing, which can almost certainly be referred to Sellards's species *Protereisma permianum*. The length of the fragment is 10 mm., and the greatest width 5.0 mm. The cross-veins, which were poorly preserved in the Sellards specimen, are very distinct and numerous.

Mecoptera. Permopanorpidae Tillyard.

Amer. journ. sci., 1926, ser. 5, **11**, p. 139.

Wings similar in general shape to those of living Panorpidae and Choristidae, but smaller; subcosta variable in length and in form of ending; R_1 strong, passing through the pterostigma, and with or without distal veinlets extending to the costa; radial sector with from four to nine dichotomously arranged branches; media with from five to eight branches, also dichotomous; Cu_1 straight and strong, terminating near the middle of the posterior margin; cubitomedian Y-vein well developed; Cu_2 straight, weak, concaved; two or three anal veins, usually simple.

Permopanorpa Tillyard.

Amer. journ. sci., 1926, ser. 5, **11**, p. 143.

Wings of variable width basally; apex well rounded; pterostigma well developed; subcosta simple or forked, terminating in the costa; R_1 usually with at least one pterostigmatic veinlet; Rs with from five to nine branches; media with six distinct branches; cubitomedian Y-vein with its branches variable.

Permopanorpa raymondi, sp. nov.

Plate **1**, fig. 3, 4. Plate **3**, fig. 1.

Type.— M. C. Z. 2,795. Kansas: Elmo.

Fore wing:— length of fragment 3 mm.; estimated length of whole wing about 6 mm.; greatest width 1.9 mm.; pterostigma 1.4 mm.; Sc joined to R_1 by an oblique cross-vein; R_1 with four costal veinlets, the first passing along the basal border of the pterostigma, and the other three extending through the pterostigma; Rs with seven branches; R_2 forked; R_{2a} and R_{2b} turned upward

at their tips; R_3 and R_4 simple; R_5 deeply forked, with the posterior member again divided at a point midway between its origin and termination; R_{5b1} joined basally to R_{5a} by an oblique cross-vein; R_{5b} also joined by two cross-veins to the media; M_1 forked to half its length; M_{1b} joined to M_{2a} by a cross-vein; M_2 forked even more deeply, with the anterior branch of the fork bifurcate in the type specimen, probably an individual characteristic; M_{3+4} dividing somewhat before the division of M_{1+2}; M_2 joined to M_3 by a stout cross-vein, and M_{3+4} united to Cu_1 by a longer cross-vein. Unfortunately, the margin of the rock passes through the middle of the wing, so that the basal half is missing. The hind wing was apparently folded and creased, only the front portion being clear. The part of this wing that is distinct is similar to that of the fore wing: the pterostigma has about the same shape, size, and position; and R_1 and R_2 are developed as in the fore wing. The characteristics of the remaining veins are obscured by the hind margin, which has apparently folded over the middle of the wing.

The part of this specimen that was secured is beautifully preserved, the veins appearing as dark brown lines, in contrast to the light color of the rock in which the insect was imbedded. The sockets of the macrotrichia are very distinct on all of the longitudinal veins, and in some places the entire hair is evident. This is especially true of the veins of the hind wing, where the trichia are 80 microns long. The hairs on the pterostigma are slightly longer, being 90 microns long. The margin of the wing is bordered by a fringe of finer hairs, 56 microns long, such a fringe as this being present on the wings of the living Panorpa.

Besides the wings there are also two fragments of legs. One of these is very small, but the other is a whole joint, and, judging from the presence of a terminal spur, is a tibia. This joint (Plate 3, fig. 1A) is 1 mm. long; the spur .2 mm. long; and the hairs which cover the fragment are 140 microns long. It is indeed unfortunate that the rock containing the specimen fractured in such a way that the body and left wings of the insect could not be secured.

This species is the eighth to be described within Permopanorpa. The venation of *P. raymondi* combines many characteristics of the veins of several other species, but appears, in all cases, to have distinguishing features. Its venation is very close to that of *P. tenuis* Tillyard,[1] but differs mainly in the possession of a deep fork on R_{5b}, and

[1] To avoid confusion it should be noted that the figures of *P. tenuis* Tillyard and *P. inaequalis* Tillyard are incorrectly named in Dr. Tillyard's paper (Amer. journ. sci., 5, 11, p. 146–147). Figure 8 is *P. tenuis*, and Figure 9 is *P. inaequalis*, and the descriptive titles under these figures should be interchanged. The references in the descriptions are also reversed.

in the position of the pterostigma, which in *P. tenuis* begins quite a distance beyond the first costal veinlet of R_1. Because of this similarity, I have added, in dotted lines and somewhat diagrammatically, the basal halves of the veins of *P. tenuis* to the figure of *P. raymondi*, merely to indicate a possible origin of the veins. This new species is also similar to *P. inaequalis* Tillyard, but is readily separated by the shape of the wing, the position of the pterostigma, and by the possession of a simple R_4, and a branched R_5. It also resembles *P. schucherti* Tillyard to a striking degree, but is distinguished by the great difference in the number of cross-veins, by the division of R_{5b}, and by the upward turning of R_2 and R_3.

Copeognatha. Psocidiidae Tillyard.

Amer. journ. sci., 1926, ser. 5, **11**, p. 319.

Fore wing:— comparatively long and narrow, the breadth being between one third to one fourth the wing-length; subcosta either entirely free or fused basally with R, usually terminating on R_1; area between R_1 and Rs usually without a cross-vein, occasionally one present; median cell open; areola postica flattened, two to three times as long as high, and not connected with the media by a cross-vein.

Dichentomum Tillyard.

Amer. journ. sci., 1926, ser. 5, **11**, p. 320.

Fore wing:— Sc distally forked, terminating at about half the length of the wing; R_1 with a pterostigmatic area between R_{1a} and R_{1b}; Rs arising at a point on the radius about one fifth the length of the wing from the base, and continuing nearly straight up to the well-developed distal fork; basal portions of M, Cu, and R distinct, but lightly chitinized; 1A close to Cu, but diverging distally; 2A remote from 1A basally, but converging distally; cross-veins apparently absent.

Dichentomum complexum, sp. nov.

Plate **2**, fig. 1. Plate 3, fig. 2.

Type.— M. C. Z. 2,792. Kansas: Elmo.

Length of wing 4.5 mm.; greatest width 1.5 mm.; pterostigma short and weakly developed; Sc quite remote from the costal margin, and terminating on R_1; R straight at the base but soon bending upward toward the anterior margin; Rs curved slightly backward just beyond its origin, terminating in a broad distal fork; M weakly chitinized, and apparently free from R at the base;

Rs distally forking to very nearly the same depth as M; M_{1+2} and M_{3+4} separating quite a distance beyond the origin of Rs; M_{3+4} with a narrow fork; Cu_1 with a very wide fork; Cu_{1a} twice as long as Cu_{1b}, and curving slightly upward just beyond its origin; Cu_2 joining Cu_1 at the very base of the wing; Cu_2, 1A, and 2A distributed as indicated in the generic description.

This is the second specimen and species known in the genus, the other being *D. tinctum* Tillyard. These two species can be distinguished as follows:—

1. Pterostigma elongate, well developed; M_{1+2} forked much more deeply than Rs..... *tinctum*
2. Pterostigma roundly oval, weakly developed; Rs and M_{1+2} forked to nearly an equal depth..... *complexum*

Protorthoptera.

The Protorthoptera are the dominant insects of the Elmo limestone, but they represent an entirely different division of the group from those taken in other localities and horizons. In general they are smaller, some having wings only 4.5 mm. long. Their wing-venation is comparatively specialized, usually reduced, so that there is some doubt as to the true position of these insects. In many cases the reduction has progressed so far that the venation simulates that of some living insects, particularly neuropteroids. A study of a large collection of these specialized forms may indicate that they are only closely related to the Protorthoptera, and not actually within the order. Unfortunately, the M. C. Z. collection contains only isolated wings. It is worth noting that all these specimens are fore wings, and this is interesting since the fore wing is usually the part best preserved in all described Protorthoptera, and often the only structure by which a species is known. This would seem to indicate, as has often been assumed, that the fore wing of the members of this order was heavier or stronger, though still membranous, than the hind wing, and hence more capable of preservation; in two families (Lepiidae and Probnisidae) from the Kansan Permian, however, the fore wing was distinctly coriaceous.

Because of the excellent preservation of the Kansan material, the Protorthoptera obtained there have thrown light upon the nature of the wing-surface of this order of insects. Sellards has mentioned minute scales on the wing-membrane of genus Lemmatophora, but since no photograph of such a wing accompanies the description, and the

scales are not further mentioned, the exact nature of this wing-structure is obscure. Sellards also noted a few hairs on the costal border of the fore wing of *Lemmatophora horsinuta*. Four of the protorthopterans (M. C. Z. 2,786a-b, 2,790b, 2,791a, 2,794) have hairs preserved on the wings. In one specimen (M. C. Z. 2,786b) these hairs are so clear that even the points are discernible. A few large hairs, 60–70 microns long (probably comparable to macrotrichia), are confined to the basal half of the subcosta, being completely absent from the membrane and the remainder of the veins. Minute hairs, 30–40 microns long, are densely distributed over the entire wing-surface.

Lemmatophoridae Sellards.

Amer. journ. sci., 1909, ser. 4, **27**, p. 162. Handlirsch, Rev. palaeoz. insekten, 1919, p. 43.

The following characters were assigned to this group:—

Wings membranous, as long as the abdomen; pronotum with a membranous expanse; subcosta simple, terminating near or beyond the middle of the wing on the costal border; radial sector simple to four-branched; cubitus one- to three-branched; Cu_2 simple; anal furrow distinct and the area containing one or two strong veins; cross-veins strong, but not numerous.

Handlirsch places the forms with these characters, together with others from the same locality, in an order which he calls "Protorthoptera vel Protoblattoidea." However, an examination of their venation indicates that the veins were developed along quite different lines from those of the protoblattids, where the longitudinal veins tend to concentrate along the axis of the wing. If the lemmatophorids, as represented by such a type as Estadia, are to be removed from the Protorthoptera, their closest affinities are not with the Protoblattoidea.

The Lemmatophoridae include seven genera, which may be distinguished as follows:—

1. Cu_1 forked ..... *Lectrum*
1. Cu_1 simple ..... 2.
2. Radial sector fused to M_1; M_2 branched ..... 3.
3. Both Cu_1 and Cu_2 simple ..... *Prosaites*
3. Cu_1 branched ..... 4.
4. Radial sector bifurcate ..... *Estadia*
4. Radial sector simple ..... 5.
5. Subcosta close to anterior border; radial sector fused to M_1 before middle of wing ..... *Paraprisca*

5. Subcosta remote from anterior border; radial sector fused to M_1 beyond middle of wing ..... *Lisca*
2. Radial sector free from M_1; M_2 simple or branched ..... 6.
6. Radial sector simple ..... *Lemmatophora*
6. Radial sector forked; radius bifurcate ..... *Artinska*

Estadia Sellards.

Amer. journ. sci., 1909, ser. 4, **27**, p. 166.

Front wings elongate; subcosta arched at the base and extending two thirds of the wing-length; radial sector arising 3 or 4 mm. from the base, fusing for a short distance with M_1; media dividing before origin of sector; Cu_1 bifurcate; two anal veins.

Estadia tripunctata, sp. nov.

Plate **2**, fig. 2–4. Plate **3**, fig. 3.

Type.— M. C. Z. 2,786a, b. Kansas: Elmo.

Length of wing 9 mm.; greatest width 5 mm.; costal and hind margins curved, apex well rounded; radial sector with its anterior branch forked at its tip, and the posterior branch simple; M_1 and M_2 forked, but M_2 more deeply.

This wing is so perfectly preserved that the coloration is still evident, showing three well-defined pigment patches: one near the center of the wing, just beyond the fusion of Rs and M; another at the base, between R and M; and a third between Cu_1 and Cu_2. The micro- and macrotrichia are also preserved. The microtrichia, 30–40 microns long, are distributed over the whole wing surface; but the macrotrichia, 60–70 microns long, are confined to the basal half of the subcosta.

The four described species of this genus can be distinguished as follows:—

1. Radial sector fused with M_1 for a distance of 1 mm. ..... *elongata*
1. Radial sector fused with M_1 for a distance of not more than 0.5 mm. ..... 2.
2. M_1 simple ..... *tenuis*
2. M_1 forked ..... 3.
3. Radial sector fused with M_1 for a distance of 0.5 mm. M_{1+2} with a shallow fork ..... *arcuata*
3. Radial sector fused with M_1 for a distance not greater than 0.1 mm., so that the two veins appear to cross, rather than fuse. M_{1+2} with a deep fork ..... *tripunctata*

The order Protorthoptera is also represented in the collection by a number of other fossils, which are not so well preserved as the preceding. One of these (M. C. Z. 2,793) is *Probnis speciosa* Sellards. Two species of Artinska (M. C. Z. 2,789, and M. C. Z. 2,790a-b), one species of Lemmatophora (M. C. Z. 2,788a-b), and one species of Stemma (M. C. Z. 2,791a-b) also represent the order, all of these apparently being new species; but since the study of the Protorthoptera in the large Yale collection has not yet been completed, it seems wiser to wait for these new species to be described from this latter collection, which may contain better specimens of the same forms, rather than to attempt a classification based upon inadequate material.

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1926c. Kansas Permian insects. Part 9. The order Hemiptera. Amer. journ. sci., ser. 5, **11**, p. 381–395.

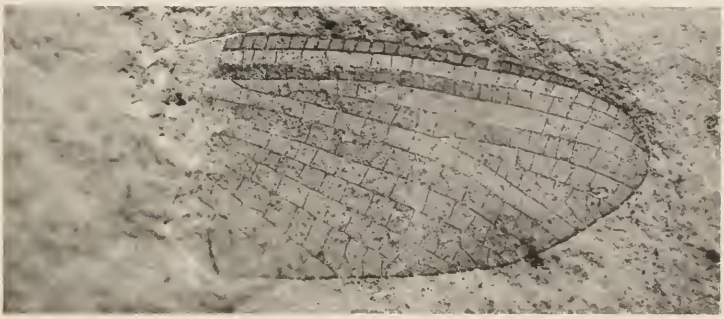
EXPLANATION OF PLATES.

PLATE 1.

PLATE 1.

Fig. 1. Costal brace of a species of Protereisma sp. (M. C. Z. 2,796).
Fig. 2. *Protereisma permianum* Sellards ? (M. C. Z. 2,785a).
Fig. 3. *Permopanorpa raymondi* Carpenter, with the distal part of the fore wing in focus. (M. C. Z. 2,795).
Fig. 4. *Permopanorpa raymondi* Carpenter, with the remainder of the fore wing and the hind wing in focus. (M. C. Z. 2,795).

1



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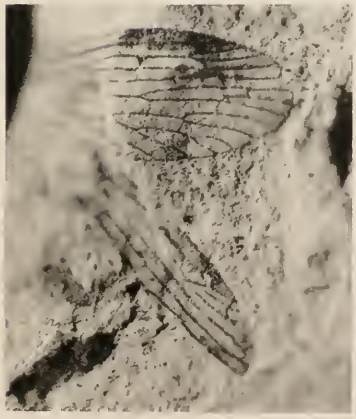

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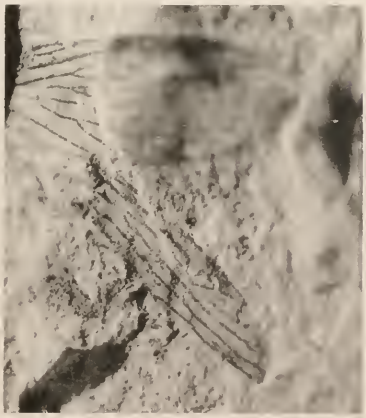

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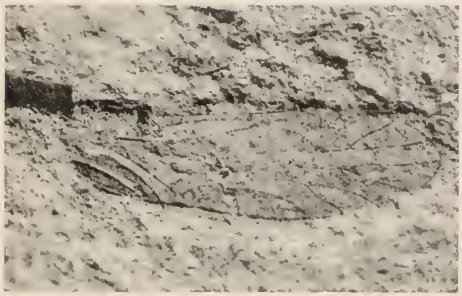
PLATE 2.

PLATE 2.

Fig. 1. *Dichentomum complexum* Carpenter. (M. C. Z. 2,792).
Fig. 2. *Estadia tripunctata* Carpenter. Photomicrograph of hairs. (M. C. Z. 2,786b).
Fig. 3. *Estadia tripunctata* Carpenter. (M. C. Z. 2,786a).
Fig. 4. *Estadia tripunctata* Carpenter, showing hairs covering wing-surface. (M. C. Z. 2,786b).



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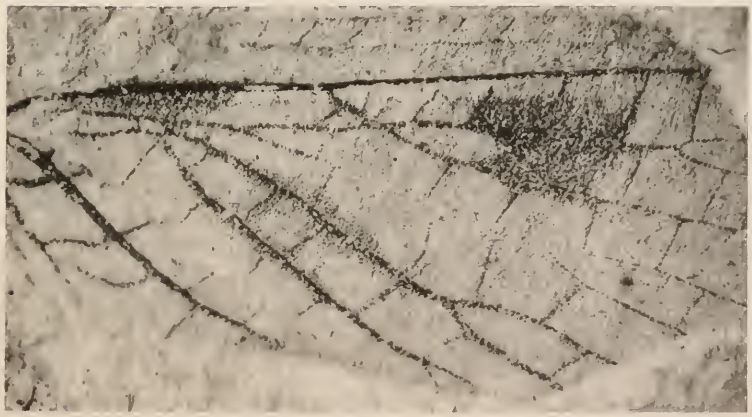

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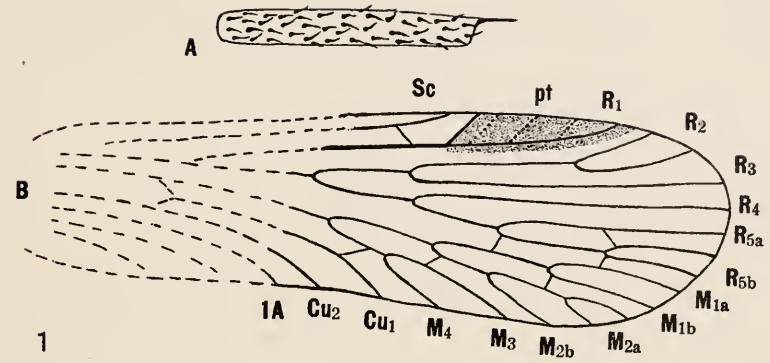
PLATE 3.

PLATE 3.

Fig. 1. *Permopanorpa raymondi* Carpenter. (M. C. Z. 2,795). A. Tibia. B. Venation.

Fig. 2. Venation of *Dichentomum complexum* Carpenter. (M. C. Z. 2,792).

Fig. 3. Venation of *Estadia tripunctata* Carpenter. (M. C. Z. 2,786a). The branches of the media are lettered on the assumption that the media in the Protorthoptera divided into four principal members, although this vein may actually have divided only into two. In that case, M_1 of the figure would become M_{1a}, M_3 would become M_{2a}, etc.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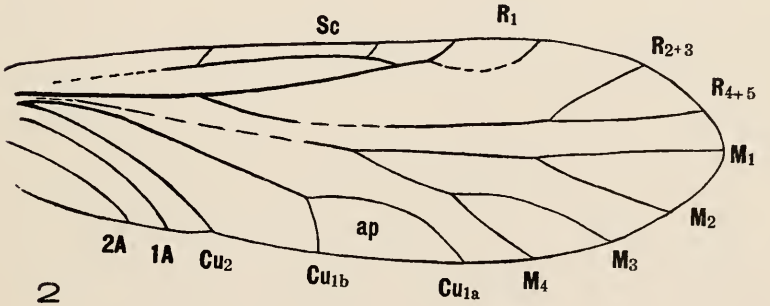
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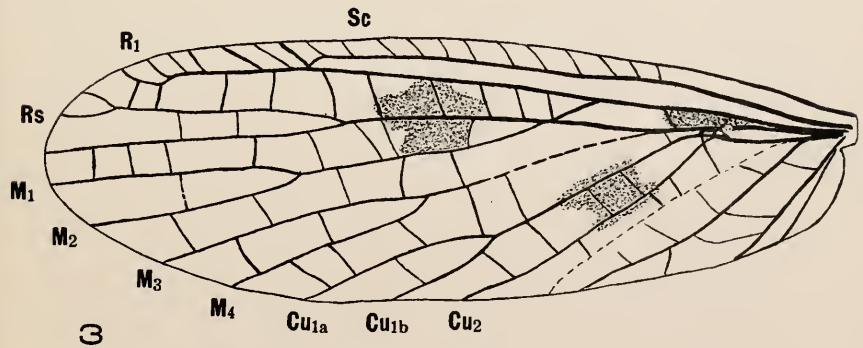
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Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LXVII. No. 14.

FOSSIL MAMMALS FROM SOUTH CAROLINA.

By Glover M. Allen.

With Five Plates.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
July, 1926.

No. 14.— *Fossil Mammals from South Carolina.*

By Glover M. Allen.

The phosphate beds of Ashley River, South Carolina, have long been known for their interesting though fragmentary remains of vertebrates, most of which have been obtained in digging the phosphate for commercial uses. Fifty years and more ago, when this industry was active, many private collections were made by interested citizens of Charleston, and a quantity of the fossils secured during the operations of the phosphate companies were thus preserved,— for the most part, however, without record of exact locality or horizon.

Of this material, there is a considerable collection at the Charleston Museum; and other collections have been in private hands at Charleston. Two of the last, the William Pringle Frost collection and the Rev. Robert Wilson collection, have lately been acquired for the M. C. Z., and form the basis of the following notes on their mammalian remains. The Wilson collection contains also the type specimen of the Oligocene sea turtle, *Carolinochelys wilsoni* Hay, comprising a cranium and a humerus.

The first comprehensive account of the fossils found in these deposits was that of Leidy, published in 1860, as part of Holmes's Post-pleiocene fossils of South Carolina. A few other papers have dealt briefly with some of the vertebrates, and Hay (1923) has listed those species of mammals that he regards as of Pleistocene age, with the descriptions of a few new ones. Pugh (1905) has given an account of the invertebrates and the general geological conditions. He regards the Pleistocene deposits as resting in many places, at least, upon a Miocene marl, of which much has been eroded away. This is again underlain by an Eocene marl. The fragmentary nature of most of the mammalian remains is evidence of the erosion to which the beds originally containing them have been exposed. Practically all are dissociated pieces, centra of vertebrae, portions of teeth, or more or less characteristic bits of skull or large bones. So far as they can be identified, most, at least, of the land mammals appear to be of Pleistocene species, a few perhaps of earlier age, while most of the marine species are of an equally Miocene facies. Since, however, none of the specimens is from a precisely known level, the horizon is in most cases partly conjectural.

Felis sp. (? couguar Kerr).

A fragment of a lower jaw from the canine to slightly behind the tooth-row, though lacking the crowns of the teeth, is practically identical in size with that of the living Puma of the eastern United States. It differs, however, from various specimens of the latter, in that the anterior root of the first premolar is very much smaller (of less diameter) than the posterior root, both of which are broken short off. Although no other modern specimen has been seen that equals this in the disparity between the two roots, it seems more likely that it is a matter of individual variation than of specific difference. The transverse diameter of the anterior root of the first premolar is 3.8 mm., of the posterior root, 5.4 mm., both measurements at the upper edge of the alveoli. The length of the tooth-row exclusive of the canine is 47 mm. Hitherto the only cat reported from these deposits is *Lynx rufus*.

Castoroides ohioensis Foster.

Ann. rept. Geol. surv. Ohio, 1838, **2**, p. 81, fig. A–D.

Two molars and the distal end of an upper incisor represent the Giant Beaver. Its presence among the Ashley River fossils has been reported by Leidy (1860), as well as more recently by Hay (1923). The latter author calls attention to the peculiarities of two fragments of upper incisors from the vicinity of Charleston, now in the collection of Yale University. These are more strongly curved than the teeth of more northern animals, with finer striations on the outer face of the tooth, while on the front of the tooth, more of the large ridges are directed obliquely and terminate along a prominent groove that passes down the face of the tooth. These same peculiarities are well marked in the single fragment from the Frost collection, so that, as suggested by Hay, it is possible that these represent an undescribed species. The tooth is a large one, with a fore-and-aft diameter of 27 mm., and a transverse diameter of 29 mm. at about 70 mm. from the cutting edge.

Hydrochoerus pinckneyi Hay.

Pub. 322, Carnegie inst. Wash., 1923, p. 365, fig. 18.

An upper posterior molar represents this species, described lately by Hay from the collection of Mr. Charles C. Pinckney, of Charleston, South Carolina. It agrees in its large size with the type specimen as

figured, but lacks a few of the posterior plates, probably the last four, since Hay's specimen had seventeen and ours has but thirteen. The tooth agrees in its general structure with that of the living Hydrochoerus, but is larger than in any specimen of the latter with which it has been compared. At the anterior end the two first transverse plates are connected at the inner side, forming a V. The thirteen plates measure 52 mm. in length, and their greatest transverse width is 19 mm. The collection contains a second smaller fragment of a similar tooth.

If the large incisor tooth from this locality (Ashley River), described by Leidy as *Oromys aesopi*, and later figured by him in Holmes's Post-pleiocene fossils of South Carolina (1860) with three cheek-teeth of a large Hydrochoerus, as *Hydrochoerus aesopi*, is really referable to the latter genus, (as seems probable), then *Hydrochoerus pinckneyi* would best be regarded as a synonym of *H. aesopi*.

Megatherium mirabile Leidy.

Proc. Acad. nat. sci. Phil., 1852, p. 117.

A fragment of a molar is included in the Wilson collection, and is recorded by Hay (1923). It came from Ashley River at the Charleston Mining Company's works. Its greatest transverse diameters are 54 by 46 mm. Presumably it is of early Pleistocene age, perhaps, as suggested by Hay, of the first interglacial or Aftonian stage. There are also in the collection unidentified fragments of very large bones that may represent the same species.

Mylohyus pennsylvanicus (Leidy).

Dicotyles pennsylvanicus Leidy, Ann. rept. Geol. surv. Penn. for 1887, 1889, p. 8, pl. 2, fig. 3–6.

A single lower molar, the posteriormost of the left-hand side, is apparently of this species, which hitherto has not been reported from South Carolina. It forms part of the Wilson collection. This tooth is of about the same size as the corresponding one of the White-lipped Peccary, but differs in having a strong cingulum across the front, extending around the outer half of the tooth. The dimensions are:— greatest length, 23.7 mm., greatest width (across anterior pair of summits), 15 mm.

Dinohyus (?) mento, sp. nov.

Plate 1.

Type.— M. C. Z. 17,015. S. C.: near Charleston. Ashley River phosphate deposits. Robert Wilson Coll.

Locality and Horizon.— Near Charleston, South Carolina, from the Ashley River phosphate deposits. Horizon not known, but supposed to be not later than Miocene.

Description.— The type consists of the symphyseal region of the lower jaws, including the alveoli of two enormous canines, succeeded by those for the first and second premolars of each side. The region of the incisors is broken away, except for a portion of an alveolus bordering the left canine. The submental surface and sides of the rami are entire.

Viewed from the front, the bony portion of the chin forms a nearly plane, forward-sloping shield, whose lateral borders diverge slightly at the anterior corners of the enormous sockets for the canines. In side view, the lower border of the rami of the jaws forms an angle of about 145 degrees with this anterior surface. At the junction of these two planes there is on each side a slight pinching-in of the rami, so that a very low rounded knob is formed, quite as figured by Peterson (1909) in Dinohyus. Unfortunately the rami are broken just in front of the level where the second and more prominent bony knob would have been, had the jaw resembled that shown by this author. There is a single large foramen, slightly counter-sunk in the surface of the bone, for the exit of the facial nerve, about under the posterior border of the first premolar. In *Dinohyus hollandi* Peterson figures two foramina, one posterior to the other.

It is unfortunate that all the teeth have been lost. The alveoli of the second premolars are filled with solidified marl, but those in front are quite free from matrix, as if the teeth had only recently fallen out.

So far as the alveoli may indicate, there was on each side at least a pair of incisors, with room for three pairs as in Dinohyus. There is actually present, however, but the outer part of the alveolus of the left incisor, whose long axis shows that the tooth projected forward more than the canine against which it abuts, and from which a thin wall of bone separates it. The canines must have been of great size and pointed slightly outward. In section as shown at the alveolar level, they were somewhat rectangular with rounded corners, the long axis nearly anteroposterior, and the anterior side slightly shorter than the posterior.

Since all the teeth are lost, the alveoli give the only indication of their dimensions. The outer incisor, represented by a portion of the alveolus, had a vertical diameter of about 20 mm. near its crown. The socket of the canine is nearly intact on the left side, and shows a diameter of 74 mm. in the direction of the long axis of the jaw. Its greater transverse diameter at its lingual side is 57 mm., narrowing to about 35 mm. at the front of the jaw. The room-cavity itself is some 130 mm. deep.

The first premolar seems to have been nearly in contact with the posterior base of the canine, from which it is separated by a bony wall 3.5 mm. thick. The tooth was double-rooted, the posterior root slightly the larger, and apparently differed from that of *Dinohyus hollandi* in that its long axis is at an angle to the line of the tooth-row, with its posterior end turned outward some 43 degrees. The long diameter of the tooth at the alveolar level was about 42 mm., the transverse diameter about 29 mm. A diastema of 25 mm. intervenes between this and the second premolar, but the alveolus of the latter is so filled with an extremely hard, marly matrix, that it has not been possible to excavate it for a determination of its limits. Beyond this point the jaws are broken off.

Width across the center of the canines, 180 mm.; greatest depth of jaw from the submental knob to upper border of alveoli of canines, 140 mm.; width between inner edges of alveoli of first premolars, 100 mm.; width across the outer edges of submental knobs, 120 mm.

Remarks.— This is the first record of the presence of an entelodont in the Ashley beds. Marsh, however, in 1893, described a single tooth from the Miocene of New Jersey as *Ammodon leidyanum*, which is now regarded as the fourth lower premolar of a large entelodont, while a second tooth, perhaps belonging to the same specimen, is regarded as a third molar. According to Peterson these are slightly larger in proportionate size than the corresponding teeth of *Dinohyus hollandi*. It is thus possible that the South Carolina fragment here described may be of the same species as the two teeth described by Marsh. Since, however, there is no way at present of comparing the two species, based on different parts, and since the character of the chin agrees closely with that of Dinohyus, the South Carolina specimen may provisionally be referred to that genus, of which it represents a somewhat larger species, differing, so far as the fragment shows, in having the first lower premolar turned strongly outward at its posterior end, and in having but one instead of two large exits for the facial nerve.

There is little to indicate its probable age. The associated land mammals are chiefly, at least, early Pleistocene species, but no entelodont is at present satisfactorily known from so late a period. The fact that the posterior tooth-sockets are filled with indurated marl may indicate that the fragment was deposited in the earlier Tertiary marl beds while they were forming. The fresh appearance of the anterior sockets of incisor, canines, and right premolar is doubtless due to the retention of the corresponding teeth till a more recent time.

Procamelus minor (Leidy).

Auchenia minor Leidy, Proc. Acad. nat. sci. Phil., 1886, p. 12.

A well-preserved astragalus of a camel from Ashley River conforms very closely in its dimensions to those given by Leidy and Lucas, (Trans. Wagner free inst. sci., 1896, **4**, p. 59), for this species as represented by a specimen from the Alachua clays of Florida (recorded by them as *Procamelus medius*). Its greatest length on the external side is 71 mm., on the internal side, 61 mm.; greatest breadth at distal end, 49 mm. Hay believes that the Florida *P. minor* is early Quaternary, perhaps of the first interglacial stage, rather than of Pliocene or even Miocene age as usually supposed.

Hay (1923, p. 364) has listed the genus Camelops from the phosphate beds of Ashley River on the basis of a specimen that he examined at Charleston.

Odocoileus sp. *cf.* virginianus (Boddaert).

Two fragments of the basal portions of shed antlers in the Wilson collection are not distinguishable from the corresponding parts of the living Virginia Deer. Each consists of a small section including the burr and the broken stump of the basal snag, with a short portion of the roughened beam. Two similar specimens, one of large diameter, were received with the Frost collection.

Bison sp. *cf.* bison (Linné).

A single tooth, the last lower molar of the left-side, is in the Wilson collection from Ashley River. It is slightly smaller than corresponding teeth from Big Bone Lick, Kentucky, though within the limits of variation for the existing Bison. Its greatest length in the direction of the jaw axis is 37.5 mm. It is unusual in having a small accessory column in the second (posterior) valley of the outer face of the tooth, of three fifths the height (19 mm.) of that in the anterior valley (31 mm.). This second accessory column is usually absent in teeth of the living Bison. Hay (1923) mentions a bone of an undetermined species of Bison from the same locality, and Leidy (1860) recorded a large tooth which he referred to *Bison latifrons*.

Undetermined ?bovid.

A fragment of the horn-core of an unrecognized species recalls some member of the Bovidae. It comprises the terminal 122 mm., is of

rather solid structure, with fine pittings and linear roughnesses on its surface. Two canals penetrate it from the broken section to the extreme top, and a faint median groove can be traced on the surface of one of the flatter faces. The section is a regular ellipse, 30 by 23 mm. at the base. The texture and general appearance are quite different from those of the beak of the fish Histiophorus, a fragment of which is also in the collection, though the shape is somewhat similar.

Equus complicatus Leidy.

Proc. Acad. nat. sci. Phil., 1858, p. 11.

A number of isolated horse teeth in both the Frost and Wilson collections appear to represent two species. The larger is *E. complicatus*. The smaller is Leidy's *E. fraternus*, renamed *E. leidyi* by Hay, on the ground that the tooth selected as the type of *fraternus* by Cope, was in reality that of *E. complicatus*, of which it thus became a synonym.

Equus leidyi Hay.

Proc. U. S. N. M., 1913, **44**, p. 572.

Equus fraternus Leidy, Holmes's Post-pleiocene fossils of S. C., 1860, p. 100, pl. 15, fig. 6, 8, 16–18; pl. 16, fig. 23, 28.

Teeth of this species in the collections add nothing to previous knowledge. Evidently this and the preceding were common in South Carolina in the early Pleistocene. Hay (1923) records many teeth examined from the vicinity of Charleston, including specimens in the Charleston Museum, in the various private collections in Charleston, and in the Scanlan collection at Yale University. In the last-named, are two lower molars from near Charleston that Hay (1923, p. 193) refers to still a third species, *Equus littoralis*.

Tapirus haysii Leidy.

Holmes's Post-pleiocene fossils of S. C., 1860, p. 106, pl. 17, fig. 7–10.

A penultimate upper molar with its posterior edge broken away, (from the Frost collection), agrees precisely in its large size with teeth of this species from Mississippi, Kentucky, and Indiana, figured in Holmes's Post-pleiocene fossils, and evidently represents a species much larger than those now living in Central and South America. The

greatest transverse diameter of the molar (crown) is 32 mm. A few other fragments of lower teeth, including a first premolar of the right-side, from the Wilson collection, are referred to the same species.

? Teleoceras proterus (Leidy).

Aphelops proterus Leidy, Proc. Acad. nat. sci. Phil., 1885, p. 33.

A large flake from the outer side of a molar represents unmistakably a rhinoceros. It is probably from a second upper molar, and agrees in general with the same part in a tooth of *T. fossiger*, so is provisionally referred to the eastern species of that genus. In his work on the Pleistocene of eastern North America, Hay lists *Teleoceras proterus* from but four localities, all in Florida. The occurrence of a large and possibly identical species in South Carolina is therefore of interest. It is recalled that Packard in 1871 mentioned "rhinoceros" among the large mammals whose remains have been found in the Ashley River beds.

Gomphotherium rugosidens (Leidy).

Mastodon rugosidens Leidy, Proc. Acad. nat. sci. Phil., 1890, p. 184.

Three nearly complete molars and a few smaller fragments of teeth are referred to this species. The larger specimens show, with wear, the trefoil enamel foldings of the cones on one border, while those of others are less complex, consisting of two cones side by side. The valleys between the transverse crests are partly filled by smaller central projections. The lateral surface of the tooth is marked by fine ridges like closely placed contours from the base to the tip of the crests, but these disappear with slight wear, and their presence is hardly characteristic, for they occur on the teeth of other mastodons as well. So far as specimens at hand indicate, they differ little from teeth of *Gomphotherium floridanum* from Polk Co., Florida, though lacking the well-developed cingulum of the latter. Leidy's original specimens were from Beaufort, South Carolina, and are believed to be of Upper Miocene or Lower Pliocene age.

Elephas columbi Falconer.

Elephas (*Euelephas*) *columbi* Falconer, Quart. journ. Geol. soc. London, 1857, **13**, tab. ad. p. 319.

In the present somewhat uncertain state of our knowledge of the American fossil elephants, the specific identification of dissociated

teeth is a trifle hazardous. There are, however, among the specimens received with the Wilson collection, several large fragments of molars which accord well with Osborn's recent characterization of the type of *E. columbi* and the neotype of the same which came from the phosphate beds of Charleston, South Carolina. These agree in having six ridge-plates in 100 mm. half-way down on the crown, in the case, at least, of the posterior teeth. In a lower third molar just coming into wear, the summits of the ridge-plates are more compressed, so that seven are included in a 100 mm. line. The transverse width of the single plates at the same level is very close to 85 mm. in these specimens.

Falconer in his original description gives no precise locality for the type specimens of his species, but mentions merely Mexico, Georgia, and Alabama.

Other fragments of elephant teeth from these same beds are much wider and higher, though with about the same thickness of ridge-plate. One of these consists of three plates whose combined thickness is 50 mm. (or six ridge-plates to 100 mm.) but they have a much greater transverse diameter, 105 instead of 85 mm. Their vertical extent is also considerably more, some 200 mm. against about 140 mm. in plates representing a similar state of wear. Another fragment comprises four plates, some 85 mm. wide and about 140 mm. high, but their combined thickness is 100 mm., or as great as six plates of some of the other specimens. This fragment was recorded by Hay (1923) as *Elephas imperator*. It is obvious that much variation occurs in these tooth-fragments, but whether this represents individual, sexual, or specific difference is perhaps not yet determinable. Osborn (1922) considers *E. columbi* as "closely related if not identical with *E. imperator*."

Halitherium antiquum (Leidy).

Plate **2**, fig. 1, 2. Plate **3**, fig. 1–3.

Manatus antiquus Leidy, Proc. Acad. nat. sci. Phil., 1856, **8**, p. 165. Holmes's Post-pleiocene fossils of S. C., 1860, p. 117, pl. 24, fig. 5–7; Journ. Acad. nat. sci. Phil., 1869, ser. 2, **7**, p. 14; 1877, **8**, p. 214.

Manatus inornatus Leidy, Rept. U. S. geol. surv. terr., 1875, **1**, p. 336, pl. 37, fig. 16, 17.

Halitherium (?) sp., Lydekker, Cat. fossil mamm. Brit. mus., 1887, **5**, p. 12.

Trichechus antiquus Hay, Bull. 179, U. S. geol. surv., 1902, p. 583.

Trichechus inornatus Hay, Bull. 179, U. S. geol. surv., 1902, p. 584.

Remains of sirenians are common in the Ashley River deposits. Besides numerous fragments of ribs previously in the M. C. Z., the

Frost and Wilson collections add a number of more characteristic pieces from which it is clear that at least two species are represented, belonging to different genera. To the one are referred portions of the occipital shield showing strongly marked lateral ridges that converge forward, enclosing a depression; also several humeri having large capitular heads on either side of a deep bicipital groove, a high deltoid crest and laterally compressed shaft.

To the other and more massive genus are referred occipital shields with flattened tops, that meet the nearly vertical sides of the cranium in a squared edge without ridges; also two massive humeri with a thick wide shaft and the axes of its tuberosities at nearly right angles to each other. It is likely that both genera were contemporaneous in the ancient coastal waters of South Carolina, and were associated with the squalodonts whose remains occur with theirs. In other words, both these sirenians lived during Miocene times. It is of considerable interest and importance therefore to find that they resemble most nearly of known fossils, the Miocene genera Halitherium and Metaxytherium respectively of Europe, and indicate therefore a wider range for these genera in middle Tertiary times than had previously been established.

Sirenian remains from the Ashley River deposits have long been known. As early as 1844, J. L. Smith mentioned, from the extensive calcareous bed underlying part of South Carolina, rib-fragments resembling those of "Manatus," remains of a marine turtle, and a ray. Other writers have noticed the solid stone-like nature of similar rib-fragments, but have supposed them to be those of the living Florida Manatee. Leidy, in a short communication published in 1856, was the first to found a name upon any of these remains. In this paper he briefly characterizes *Manatus antiquus*, from "fragments of ribs found in the Miocene deposits of New Jersey and Virginia," and "a fragment of a rib and an isolated molar tooth, discovered by Capt. Bowman, U.S.A., in the sands of Ashley River, South Carolina." This tooth was later figured by Leidy in Holmes's Post-pleiocene fossils of South Carolina, and since it alone was described in the original account, it may be considered as the type specimen on which the species is based. The tooth is larger than that of a Manatee and differently formed. Apparently it closely resembles the upper second molar of *Halitherium schinzi* as figured by Lepsius (1881, pl. 3, fig. 18). It is, however, slightly smaller, 20 instead of 22 mm. in its longest diameters, and apparently with slightly less prominent anterior cingulum cusp. The tooth was unworn, of nearly square outline, with two distinct transverse crests, the anterior formed by protocone, protoconule, and para-

cone, the posterior by hypocone, metaconule, and metacone. The metaconule in corresponding teeth of Metaxytherium tends to be thrust more forward out of line with hypocone and metacone, so as partly to block the valley between the two crests. The close correspondence of this tooth with that of Halitherium, as well as the similarity of occipital shields to that of the same genus, seem to warrant the reference of these and other remains of the smaller sirenian to Halitherium, retaining for it Leidy's specific name on the ground of minor differences in size and formation of the penultimate upper molar, and slightly less convergence of the temporal crests. The referred humeri are also different, in having a shaft that tapers rapidly at its upper third, to a triangular and somewhat laterally compressed section with the apex of the triangle at the deltoid crest. The latter is short and turns rather steeply inward slightly below the level of the head of the humerus to a point just distal to the deep bicipital groove. It has a short, blunt, overhanging crest. The axes of the greater and lesser heads, as viewed from above, enclose an angle of about 60 degrees, much less than that in Metaxytherium. None of the available specimens has its lower end intact. Of the three referred to this species, however, the bicipital groove is relatively narrow at the summit of the humeral head, in contrast to the broader groove of Metaxytherium. Two are approximately of equal size, with a diameter of about 80 mm. across the long axis of the head. A third is much smaller, though adult, with well-fused capitular epiphyses, the long diameter of which is only 58 mm. The larger specimens are regarded as having belonged to males, the last to a female animal.

Of additional fragments, a right squamosal process including the glenoid cavity of the jaw, probably pertains to this species, as well as sundry more or less incomplete and relatively slender, flattened ribs, showing the extremely dense structure characteristic of sirenian bones. On the whole the fragments seem to resemble the Mediterranean *Halitherium christoli* rather closely.

In 1873 Leidy proposed a second name, *Manatus inornatus*, for a sirenian from the Ashley River deposits, basing his brief description on a lower tooth which he figured in side and crown views (Leidy, 1873, p. 336, pl. 37, fig. 16, 17). He points out a general resemblance to a lower tooth of the living Manatee, but says that the "constituent lobes of the crown are less contracted approaching the summits, and the intervening valleys are wider." Other minor differences are noticed. It seems likely that this was an anterior lower tooth, perhaps a milk-tooth, of *Halitherium antiquum*, for in general structure it is not widely

different from anterior lower teeth figured for European species, though smaller than any shown by Lepsius. For the present Leidy's *inornatus* may be regarded as a synonym of *antiquum*.

Still a third name has been based on sirenian remains from these same deposits, the *Dioplotherium manigaulti* of Cope doubtfully referred to the "Halitheriidae" by Hay (1902). Cope's specimen consisted of a premaxillary fragment including part of a tusk-like incisor, and, as Cope thought, the socket for an additional and smaller incisor behind the first. The specimen came from the Wando River, northeast of Charleston. It is still preserved in the Charleston Museum, and has lately been critically studied by Dr. Remington Kellogg, and found to agree in essentials with a portion of the rostrum of another specimen from the same formation in the collection of Yale University. Dr. Kellogg states that the single large tusk measures 49.5 by 25.5 mm. in its diameters, and that there is no indication of an alveolus for a second incisor as Cope had supposed. He proposes that the species be referred to Metaxytherium, which the tusk appears to resemble, a suggestion which seems quite borne out by the fragments to be mentioned. Lydekker in the Catalogue of fossil mammals in the British Museum includes under Halitherium as a blanket name, two ribs and a centrum from Ashley River.

Metaxytherium manigaulti (Cope).

Plate **2**, fig. 3, 4. Plate **3**, fig. 4, 5.

Dioplotherium manigaulti Cope, Proc. Acad. nat. sci. Phil., 1883, p. 52.
Metaxytherium manigaulti Kellogg, Publ. 348, Carnegie inst. Wash., 1925, p. 59.

The fragments at hand that I have referred to this species comprise numerous portions of ribs, together with two well-preserved occipital shields, two humeri, a portion of the base of a scapula, and a few vertebrae. The occipital shields (Plate **2**, fig. 3, 4) are very flat-topped, tapering evenly forward, and falling away laterally at an angle of nearly 75 degrees. The dorsal and lateral planes meet at the side of the shield in a well-defined edge as in the Old World species of Metaxytherium and quite without indication of a crest of ridge such as characterizes Halitherium. The flattened dorsal area is about 65 mm. wide across its posterior corners. A fragment of an unmistakable sirenian scapula from Ashley River is no doubt of this species. At its anterior side is an oval area 37 mm. long representing the base of a

coracoid process, now broken off, a process usually small in Old World species of the genus, while the glenoid cavity is much larger than in an adult Manatee, and distinctly oval with a slight indentation on the anterointernal edge. Its long diameter is 70 mm., its greatest transverse width 55 mm. The humerus is of the form and stoutness characteristic of this genus. The epiphyses of its head are lacking in both specimens, but their transverse axes include an angle of nearly 90 degrees, enclosing a broad shallow bicipital groove. The deltoid crest is continued across to the inner epicondyle at the distal end of the humerus. A section at the middle is nearly an isosceles triangle with a base (posterior) of 40 mm. and sides of 50 mm. In side view (Plate 3, fig. 4, 5) the deltoid crest is nearly parallel with the posterior side for about half the length of the shaft, then slopes rather abruptly in to the edge of the articulating surface. The humerus differs in many details from that of *M. floridanum*, which is larger, with slightly more tapering shaft (in side view), a longer trochlear area which is more nearly at right angles to the shaft. Altogether the fragments correspond to the European *Metaxytherium petersi* rather closely, but in the absence of better material for comparison they may at present be kept distinct.

The rib-fragments are for the most part indeterminate pieces, but one complete specimen is heavy and somewhat squarish in section at the middle, with diameters of about 50 mm., and a length across the chord from tip to tip of about 420 mm. It is probably referable to Metaxytherium, while smaller less thickened ribs, with ellipsoidal section are probably those of Halitherium.

Dorudon serratus Gibbes.

Proc. Acad. nat. sci. Phil., 1845, **2**, p. 254, pl. 1.

Three large, single-rooted teeth, Dr. Remington Kellogg suggests may be those of this species with which they seem in general to agree. They are pale grayish in color and share the peculiarity that a portion of the outer layer of the root has cracked off, leaving a central core of the same diameter as the crown with which it is continuous. This enlargement of the root through the addition of a thickened dentine layer gives the tooth a swollen appearance immediately below the crown.

Pertaining to this same species are perhaps two atlases in the Wilson collection, which though unquestionably of some primitive cetacean cannot be specifically allocated until associated parts are found. In these the articulating surfaces for the skull are large and slightly con-

cave, the neural crest is low, and there is a large foramen on each side below it. On each side below and behind the foramen was a lateral compressed process set at a backward-tilting angle, but these had been broken off in each atlas. The most interesting feature is the broad shallow concavity at the lower side posteriorly for the reception of a large odontoid process of the axis, while the lower edge of the atlas is produced backward in a blunt point medially. Of the two axes one is smaller with this point less pronounced, but it is otherwise similar.

Agorophius pygmaeus (Müller).

Zeuglodon pygmaeus Müller, Zeuglod. Nordamerica, 1849, p. 29, pl. 23, fig. 1, 2.

The unique skull upon which this species is based, has been lost sight of and is not known to be in existence, but the excellent plate showing three views of the specimen, as prepared for Louis Agassiz and issued many years later by True (1907), affords a fairly adequate basis for comparison. Two fragments in the Wilson collection are now unhesitatingly referred to this species: — a section of the rostrum broken from just in advance of the nares, and a piece of the left jaw containing several tooth-sockets. The former is remarkable for its vomer, which as shown in Agassiz's figure, is widely open above, broadly V-shaped in section, and recalls very much its general relations in the whalebone whales (Balaenoptera). It was perhaps this resemblance that led Gervais to regard the species as representing a stage ancestral to the rorquals. In cross-section the vomer is seen to be thickened at the upper end of each wing, the right-side more than the left. Proximally the inner margin of each intermaxillary slightly overhangs the dorsal edge of the vomer, and flares slightly outward to meet the inner border of the maxillary in a ridge that runs parallel to the outer rim of the jaw. The union of these two edges cuts off a long triangular area on each side, at the front end of which are two foramina situated one in advance of the other in a slight depression. These are clearly indicated in Agassiz's figure, though the posterior foramen was, as in our specimen, apparently filled with marl, and its position is marked by scratches. These orifices communicate with a large, somewhat flattened canal between the intermaxillary and maxillary, and the corresponding openings of the two sides lie practically in the same transverse plane. In palatal aspect, the keel of the vomer shows in the median line at about the level of the anterior of these foramina. Sockets for five double-rooted teeth appear in the fragment, corresponding exactly

with the length of the molar figured by Agassiz. The sockets are shallow and slope somewhat backward at an angle; in length the double cavities of the last four teeth of the right side are respectively 19, 16, 14, 14 mm., with spaces of 3, 4, and 5 mm. between. Breadth of rostrum at level of the anterior foramen, 90 mm.

I have associated with this interesting fragment a portion of the left mandible containing the sockets of two double-rooted teeth separated by a space of 5 mm.; the posterior of these is succeeded by a deep dimple into which the last upper tooth may have fitted. The fragment is otherwise very porpoise-like, its outer surface gently convex, its inner nearly flat. The bone is thin and the interior cavity is filled with the hardened gray marl that had penetrated the other fragment.

A comparison with the type of Archaeodelphis (which may have been derived from the same deposits as Agorophius), again emphasizes the great difference in structure of the vomer, which in the latter is a wide, open trough but in the former was a tube closed dorsally. In size the fragment of Agorophius indicates a slightly larger animal.

Saurocetus gibbesii Agassiz.

Plate 4.

Saurocetus gibbesii Agassiz, Proc. Acad. nat. sci. Phil., 1848, 4, p. 4, 1848.

Several large squalodont teeth, stained a dark blackish brown, were submitted to Dr. Remington Kellogg, who has very kindly compared them with teeth representing *Squalodon atlanticus* and *S. calvertensis*. He regards them as probably referable to *Saurocetus gibbesii*, a conclusion in which I fully concur. With the type-tooth of this species (in the M. C. Z. collection) they agree in the general height, striation of the crown, imperfect division of the roots of the double-rooted specimens, and in the color. One, apparently an incisor, has a long, nearly straight and tapering root, and a conical crown whose anterior and posterior edges are slightly keeled.

Two other long, single-rooted teeth, apparently anterior premolars, are similarly sharp-edged, but more curving.

To the same species is referred a large fragment (Plate 4) from the posterior end of a lower jaw. It contains the sockets of the five posteriormost teeth and in advance of these a small portion of another socket, but whether of a single or a double-rooted tooth cannot be told. The shape of these sockets shows that, as in the type-tooth, the division of the root into two was very imperfect, for the bony wall extends

inward for but a short distance on each side, giving the socket a figure-8 outline. The five sockets form a series decreasing in size. From the anteriormost to the last molar, the lengths of the sockets are respectively: —35, 35, 27, 24, 21 mm. The space occupied by the five is 160 mm.; depth of jaw at level of anteriormost tooth 50; at level of posteriormost 75. The fragment is from the left-hand side, is nearly straight, and proximally expands somewhat in the vertical plane, where the outer side becomes slightly convex, the inner nearly flat. Very striking is the gradual decrease in size of the molars at the end of the series, their very imperfect division into two roots, the slenderness of the ramus, and its uniform depth forward.

While this large species may be referable to Squalodon in a restricted sense, it is likely that were its characters fully known it would prove generically distinct. I am provisionally therefore, retaining the original name given by Agassiz.

Squalodon crassus, sp. nov.

Plate 5.

Type.— M. C. Z. 1,695, S. C.: near Charleston. Ashley River phosphate deposits.

Horizon.— Probably Miocene.

Diagnosis.— A large species, only slightly inferior to *S. tiedemani*, distinguished by the stoutness of the jaw and by the figure-8 outline of the two-rooted teeth whose fangs are separated quite to the alveolar level by a complete bony-septum.

Description.— Apparently none of the squalodonts hitherto named from the American deposits is quite like this species, as indicated by its fairly large size and the character of the molar roots. It is specifically identical as far as can be made out, with the lower jaw described and figured by Kellogg (1923, pl. 19) from the Calvert Cliffs of Maryland. The South Carolina specimen is a portion of the lower mandible some 270 mm. long, that includes (anteriorly) an incomplete alveolus for a single-rooted premolar, followed after an interval of 15 mm. by a second (complete) socket for a single-rooted tooth. Next come two alveoli for double-rooted teeth at intervals of 15 mm., the first 25, the second 28 mm. long. After 10 mm. follow four more double cavities for two-rooted teeth, the three last in contact. These six two-rooted teeth were probably succeeded by a seventh but the jaw is broken here. Their total length is about 190 mm. The distinguishing character of

these alveoli is their broad figure-8 outline, rather conical, tapering root-cavities, the slight divergence of the two roots, as shown by these cavities, and the complete separation of the two roots by a bony partition that extends quite to the level of the upper border of the jaw. Anteriorly on the inner face of the jaw there is a roughened area opposite the first double cavity, back of which a flattened outline, convex backward to the level of the posterior margin of the second two-rooted tooth, indicates the boundary of the symphysis. The fragment is about 50 mm. deep throughout its length and averages 32 mm. in greatest transverse diameter. It is, therefore, shallow but heavy, and closely resembles the corresponding part figured in Plate **19** of Kellogg's (1923) paper. From *Saurocetus gibbesii* it is at once distinguished by the complete bony partition of the socket separating the two diverging roots of the double-rooted teeth, and differs in the same way from *Squalodon atlanticus*, the roots of which Leidy states are united for most of their length.

There is no close resemblance between this and *Dorudon serratus*, in which the roots of the molars are much more widely divergent, and the teeth narrower in proportion.

Possibly to be associated with this or Saurocetus is a fragment of a scapula with a short, peg-like coracoid process and with a spine broken through apparently near the front edge of the relatively small blade. A fragment of an atlas (with axis), perhaps of this species, has the lateral process blunt, triangular, and set at the posterior edge of the bone at the upper end of the articulating surface, in this respect distinctly like the corresponding process in certain Delphinidae.

Physeter carolinensis (Leidy).

Dinoziphius carolinensis Leidy, Journ. Acad. nat. sci. Phil., 1877, ser. 2, **8**, p. 216, pl. 34, fig. 6.

Three large teeth are referred to this species. One is exceptionally well preserved, dark brown in color, with a smooth polished exterior, but its extreme tip is broken off. In its elongate-pyriform shape it closely resembles the tooth figured by Leidy (Journ. Acad. nat. sci. Phil., 1877, ser. 2, **8**, pl. 34, fig. 6).

Leidy remarks that teeth of this sort differ from those of the living Sperm Whale in their lack of lateral compression, and refers them to the genus Dinoziphius of Van Beneden. Hay has more recently (1902)

placed Leidy's species under Physeter, but without more knowledge of the remainder of the animal, this is at best provisional. The age is supposed to be Pliocene.

Proroziphius chonops Leidy.

Proc. Acad. nat. sci. Phil., 1876, p. 114.

A fragment representing the terminal half of a beaked whale's rostrum agrees fairly well with Leidy's description and figures of this species (Journ. Acad. nat. sci. Phil., 1877, ser. 2, **8**, p. 229, pl. 32, fig. 3, 4). This was apparently a whale with a rather short beak whose terminal portion was thickened by a mound-like oval enlargement on the dorsal half above the alveolar level, at its posterior end. This mound is about 35 mm. in height above the level of the prenarial floor, and about twice that in width, tapering to a median point proximally, and sloping away gently forward. A sharply defined lateral groove is present on each side below the level of the intermaxillaries. The section at the broken basal end of the specimen is shield-shaped, with a depression above on either side of the median ridge.

Choneziphius trachops Leidy. Choneziphius liops Leidy.

Choneziphius trachops Leidy, Proc. Acad. nat. sci. Phil., 1876, p. 81. Journ. Acad. nat. sci. Phil., 1877, ser. 2, **8**, p. 218, pl. 30, fig. 2, pl. 31, fig. 1.
Choneziphius liops Leidy, Proc. Acad. nat. sci. Phil., 1876, p. 81. Journ. Acad. nat. sci. Phil., 1877, ser. 2, **8**, p. 222, pl. 30, fig. 1, pl. 31, fig. 2.
Choneziphius leiops Leidy, Journ. Acad. nat. sci. Phil., 1877, ser. 2, **8**, p. 222.

Two fragments of beaks seem to represent respectively these two species described by Leidy. Their striking characteristics in common, are: — (1) the presence of two large spoon-shaped depressions occupying the base of the beak directly in front of the nasal openings, each running forward as a contracted groove to a foramen penetrating the solid beak; (2) the prominent ridge separating these depressions and terminating proximally in a raised triangular area asymmetrically displaced to the left; (3) the relatively shallow or flattened cross-section of the beak. The spoon-shaped depression of the right-hand side is much larger than that of the left, and encroaches upon the latter so as to narrow it to about a third the width of the larger. Since the essential differences between these two supposed species seem chiefly a matter of size relations, it is hardly to be doubted that they are really

sexual, and that the smaller specimens, *C. liops*, are, therefore, the females of *C. trachops*, the name that must stand for the species.

In the larger fragment, taken to represent an old male, the transverse diameter of the right-hand depression must have been nearly 110 mm., that of the left-hand, about 35 mm. The latter has been so compressed by the overgrowth of the right-hand hollow that it is reduced merely to a deep groove. The triangular elevation bounding the larger depression in front is nearly median with its left basal angle prolonged backward.

In the smaller fragment, *C. liops*, considered the female of this whale, the transverse widths of the two depressions are: — right-hand, 85 mm., left-hand, 45 mm. In this specimen the median ridge is worn away at its summit, and only a portion of the narrow groove-like rim bounding the intermaxillary depressions externally remains. The anterior walls of the blow-holes are also preserved and indicate that the nares were extraordinarily large as compared with those of existing species of Mesoplodon of Hyperoodon. Their combined transverse width is about 100 mm., that of the right-side slightly the wider. They must have occupied about one third of the entire width of the beak.

Eubalaena sp.

Portions of three tympanic bones so closely resemble that of Eubalaena that they are referred to this genus, and may represent the existing species.

Other cetacean ear-bones. At least two other large species of baleen whales are represented by fragments of tympanic bones in the collection. One is a larger species about the size of a Common Finback (*Balaenoptera physalus*), the other a smaller one, the tympanic fragments of which are provisionally regarded as from a Megaptera.

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EXPLANATION OF PLATES.

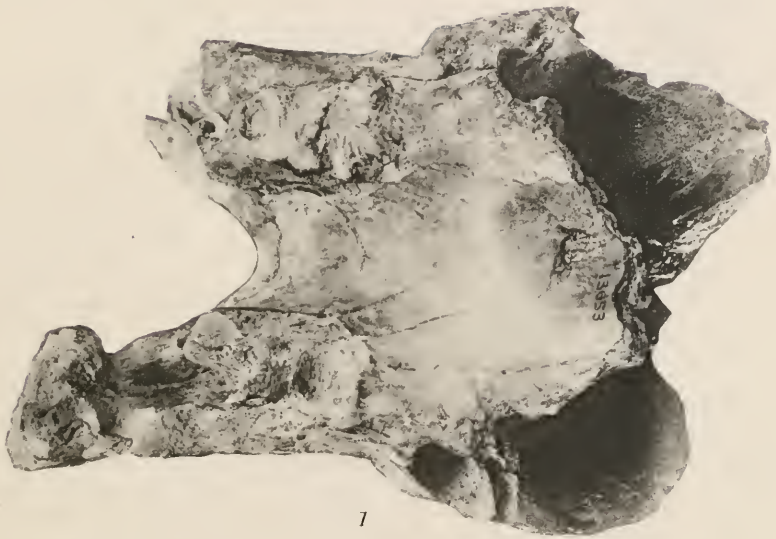
PLATE 1.

PLATE 1.

Dinohyus (*?*) *mento* Allen.

Fig. 1. Mandibular symphysis, from above, showing tooth-sockets for an outer incisor, canines, and first premolars. The type. × 0.4.

Fig. 2. The same from the right-side. × 0.4.



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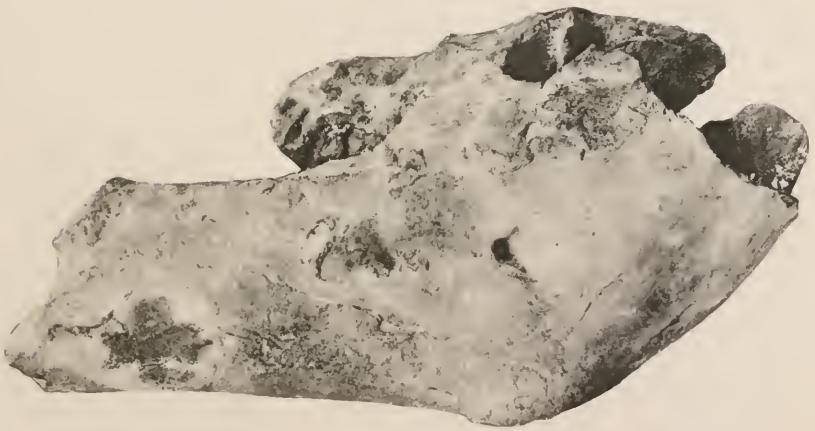

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PLATE 2.

PLATE 2.

Occipital shields of sirenians.

Figs. 1, 2. *Halitherium antiquum* (Leidy), from above, showing the converging lateral ridges. × 0.6.

Figs. 3, 4. *Metaxytherium manigaulti* (Cope), from above, showing the flat-topped occiput forming an angle with the sides of the brain-case. × 0.6.

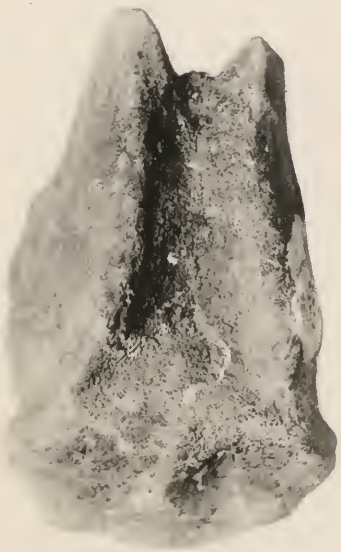

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PLATE 3.

PLATE 3.

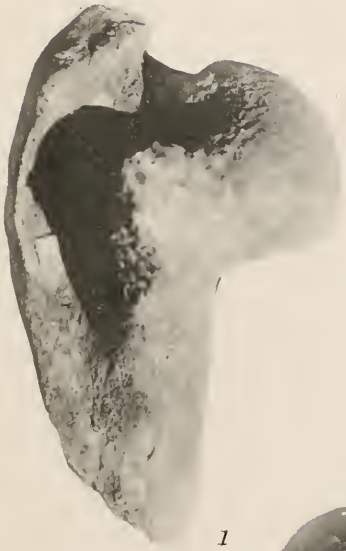
Humeri of sirenians.

Fig. 1. *Halitherium antiquum* (Leidy), head of the humerus from the inner side, showing the large tuberosities bounding the bicipital groove. × 0.50.

Fig. 2. The same from the outer side, showing the short overhanging projection of the deltoid ridge. × 0.50.

Fig. 3. A smaller specimen, perhaps a female, of the same species, inner side. × 0.45.

Figs. 4, 5. *Metaxytherium manigaulti* (Cope), outer aspect of two different humeri. × 0.40.



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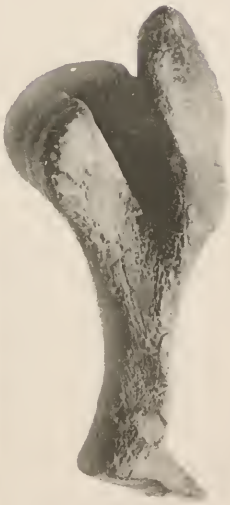

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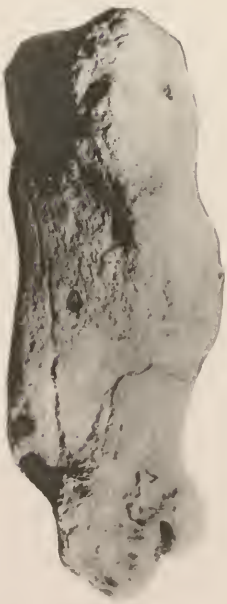

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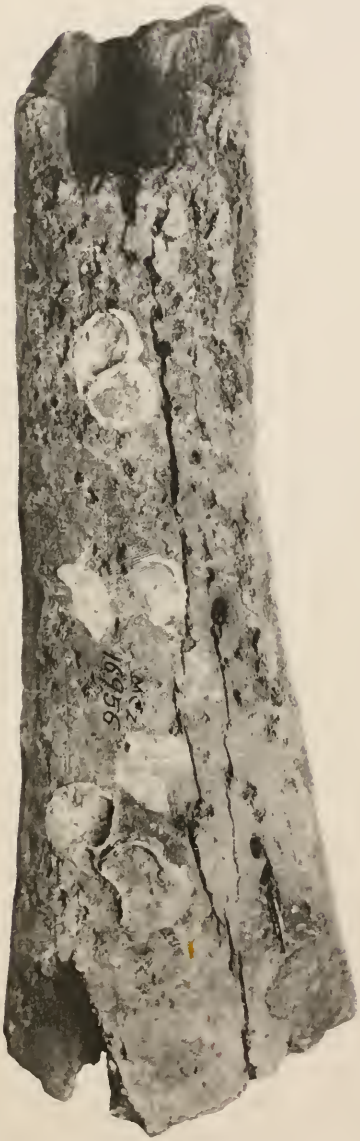
PLATE 4.

Saurocetus gibbesii Agassiz.

Fig. 1. Fragment from posterior end of lower jaw. × 0.6.

Fig. 2. The same from above, showing the sockets for the five posterior teeth, with incomplete septa for the division of the roots into two. × 0.6.



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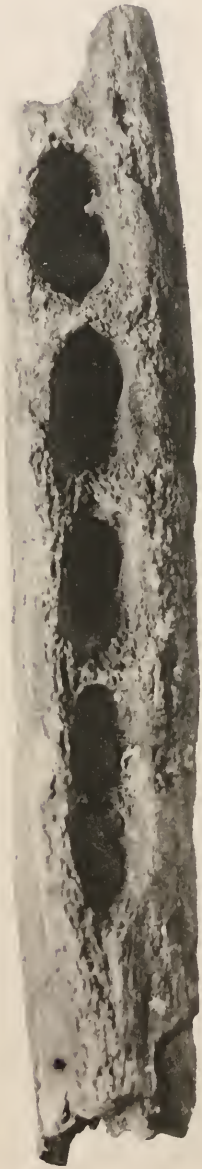

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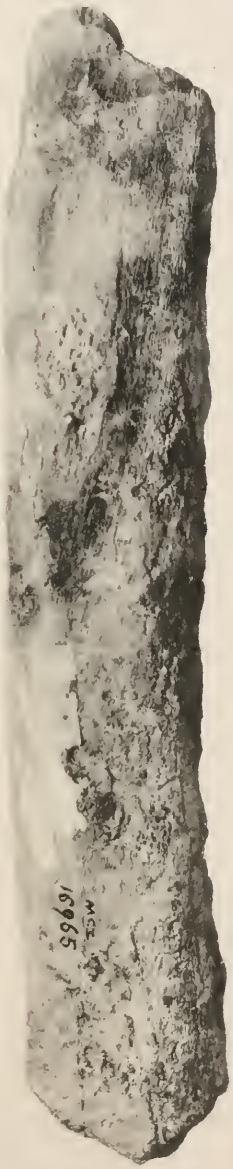
PLATE 5.

PLATE 5.

Squalodon crassus Allen.

Fig. 1. Fragment from posterior end of lower jaw The type, showing (on upper half of figure) the symphysial surface. × 0.57.

Fig. 2. The same from above, showing sockets of two single-rooted and six double-rooted teeth, with complete transverse septa dividing the roots of the latter. × 0.57.



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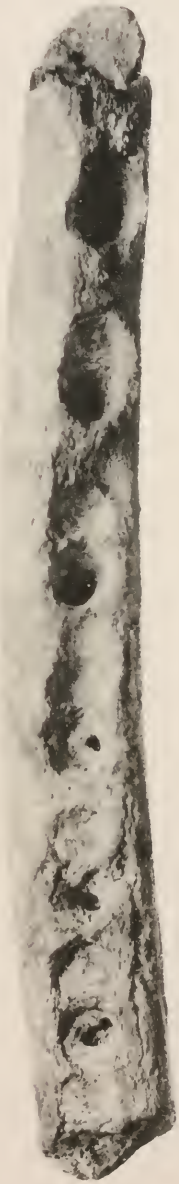

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JAN 28 1927

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LXVII. No. 15.

BIRDS FROM THE RAIN FOREST REGION OF VERA CRUZ.

By Outram Bangs and James L. Peters.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM.
January, 1927

No. 15.— *Birds from the Rain Forest Region of Vera Cruz.*

By Outram Bangs and James L. Peters.

In the winter of 1925 Col. John E. Thayer, who has done so much in the past to enrich the collection of birds in the Museum of Comparative Zoölogy, sent the veteran collector Wilmot W. Brown to Vera Cruz in search of that great ornithological rarity *Hylorchilus sumichrasti* (Lawrence). Mr. Brown went to Motzorongo where he made his headquarters at the Shaw Ranch.

He collected at two localities in the heavy rain forest of this region, Motzorongo and Presidio, of which he writes,

> The climate here is hot and steamy and there is a heavy rainfall, the mountains — most of the time veiled in mists — are heavily forested, the trees growing so close together that it makes it quite dark and gloomy underneath and difficult to see the birds. There is also a dense undergrowth and the slopes are steep and rocky.

Although Mr. Brown's main object was to secure Hylorchilus, he managed to make a fairly good representative collection of birds of the immediate region. This collection consists of about 300 specimens, which Mr. Thayer has generously presented to the Museum of Comparative Zoölogy, retaining for his own use only the North American migrants.

TINAMIDAE.

Crypturornis cinnamomeus cinnamomeus (Lesson).

One, ♀ ; Presidio, 27 April.

Tinamus (*Nothura*) *cinnamomea* Lesson (Rev. zool., 1842, p. 210) was described from "La Union, Centre Amerique" (La Union, Salvador). Through the kindness of Mr. D. R. Dickey, we have examined specimens from Salvador and find them practically identical with Mexican birds. An adult male from Tipitapa, Dept. of Managua, Nicaragua, is also the same as Salvador examples. The probability that the type of *Tinamus delattrii* Bonaparte (Comp. rend., 1854, **38**, p. 663, Nicaragua) came from northwestern Nicaragua is so great that we have no hesitation whatever in restricting that name to northwestern Nicaragua. Seven specimens collected in northwestern Costa

Rica by C. F. Underwood form a very even series, intermediate in color between *C. c. cinnamomeus* (Lesson) and *C. c. idoneus* (Todd) (Proc. Biol. soc. Wash., 1919, **32**, p. 17. Bonda, Santa Marta, Colombia) and which we therefore describe as: —

CRYPTURORNIS CINNAMOMEUS PRAEPES, subsp. nov.

TYPE.— M. C. Z. 120,855. Adult ♂. Costa Rica; Bolson, 14 December, 1907, C. F. Underwood.

Characters.— Similar to *C. c. cinnamomeus* (Lesson) but upper parts, especially the interscapular region and neck much paler and browner, less greyish; sides of neck and foreneck brown, almost entirely lacking any greyish tinge. From *idoneus*, to which it is otherwise very similar, it differs in being more sandy and less reddish brown above, and in being slightly deeper cinnamomeus on the belly.

Size and proportions as in *cinnamomeus*. *Wing*, 155; *bill from base*, 30; *tarsus*, 47.

Specimens examined: —

Crypturornis cinnamomeus cinnamomeus (Lesson). Vera Cruz. Two, ♂♂; two, ♀♀; five, sex not determined. Salvador. Two, ♂♂; two, ♀♀. Nicaragua. One, ♂.

Crypturornis cinnamomeus praepes nobis. Northwestern Costa Rica. Five, ♂♂; two, ♀♀.

Crypturornis cinnamomeus idoneus (Todd). Colombia: Santa Marta Mts. One, ♂.

COLUMBIDAE.

SCARDAFELLA INCA INCA (Lesson).

One, ♂; Presidio, 20 March.

Scardafella i. dialeucos Bangs (Proc. Biol. soc. Wash., 1905, **18**, p. 152. Boundary between Honduras and Nicaragua) has not been currently recognized, but appears to be a valid form, characterized by darker upper parts; greater extent of greyish white on the wing coverts; greater extent of white on the posterior underparts with a corresponding restriction of vinaceous on the breast, and in having heavier and more complete crossbars on the belly and abdomen. Specimens from Guatemala and Nicaragua are referable to *dialeucos*.

COLUMBA NIGRIROSTRIS Sclater.

One, ♂; Presidio, 20 March.

FALCONIDAE.

Clamosocircus guerilla guerilla (Cassin).[1]

One, ♀; Presidio, 2 April.

Rupornis magnirostris griseocauda Ridgway.

One, ♂; Presidio, 3 April.

Leucopternis ghiesbrechti ghiesbrechti (Du Bus).

Two, ♂♂; Presidio and Motzorongo, 16 February, 29 March.

STRIGIDAE.

Rhinoptynx clamator (Vieillot).

One, ♂; Presidio, 3 May.
As far as we have been able to ascertain, this specimen constitutes the first Mexican record for the species.

Ciccaba virgata virgata (Cassin).

One, ♂; Presidio, 27 March.

Glaucidium brasilianum ridgwayi Sharpe.

Four, ♂, ♀♀♀; Presidio, March.

ALCEDINIDAE.

Chloroceryle americana septentrionalis (Sharpe).

Three, ♂♂, ♀; Presidio and Motzorongo, February, March, May.

MOMOTIDAE.

Momotus lessonii goldmani Nelson.

Three, ♂, ♀♀; Presidio and Motzorongo, March.

CAPRIMULGIDAE.

Nyctidromus albicollis sumichrasti Ridgway.

One, ♂; Motzorongo, 2 March.

[1] For use of Clamosocircus *cf.* Swann, Monog. birds prey, 1925, pt. 3, p. 145.

CYPSELIDAE.

Streptoprocne zonaris mexicanus Ridgway.

Four, ♂♂; Presidio, May.

Chaetura pelagica (Linné).

One, ♂; Presidio, 6 May.

Chaetura richmondi Ridgway.

One, ♂; Presidio, 10 May.

TROCHILIDAE.

Phaethornis adolphi adolphi Gould.

One, ♀; Motzorongo, March.

Pampa pampa curvipennis (Lichtenstein).

Two, ♂, ♀; Presidio and Motzorongo, 4 March, 17 February.

Campylopterus hemileucurus hemileucurus (Lichtenstein).

Two, ♂♂; Presidio, March, May.

Agyrtria candida (Bourcier and Mulsant).

One, ♀; Motzorongo, 27 February.

Saucerottia beryllina beryllina (Lichtenstein).

One, ♂; Presidio, 1 April.

Eupherusa eximia nelsoni Ridgway.

One, ♂; Presidio, 22 March.

This specimen is practically a topotype of *nelsoni* and agrees in all the characters pointed out for it by the describer; the measurements are: — wing, 61; tail, 40; culmen to base of forehead, 19.25.

TROGONIDAE.

Trogonurus puella (Gould).

Four, ♂♂♂, ♀; Presidio, March.

Chrysotrogon caligatus (Gould).

Six, ♂♂, ♀♀; Presidio and Motzorongo, February, March, May.

CUCULIDAE.

Piaya cayana thermophila Sclater.

Two, ♀♀; Motzorongo, February, March.

Tapera naevia excellens Sclater.

One, ♀; Presidio, 6 April.

RAMPHASTIDAE.

Ramphastos piscivorus piscivorus Linné.

Two, ♂, ♀; Presidio, April.

Pteroglossus torquatus torquatus (Gmelin).

One, ♂; Motzorongo, 15 February.

Aulacorhynchus prasinus prasinus (Gould).

One, ♂; Presidio, 30 April.

PICIDAE.

Piculus rubiginosus yucatanensis (Cabot).

One, ♂; Presidio, 5 April.

Centurus dubius veraecrucis (Nelson).

One, ♀; Presidio, 24 May.

Centurus sanctacruzi grateloupensis (Lesson).

Two, ♂♂; Presidio and Motzorongo, 9 February, 21 March.

FORMICARIIDAE.

Thamnophilus doliatus mexicanus Allen.

Six, ♂♂, ♀♀; Presidio and Motzorongo, February, March, April.

Microrhopias quixensis boucardi (Sclater).

One, ♂; Presidio, 10 March.

Ramphocaenus rufiventris rufiventris (Bonaparte).

Two, ♀ ♀; Presidio, 8, 10 March.

Formicarius analis moniliger Sclater.

One, ♂; Presidio, 29 March.

FURNARIIDAE.

Synallaxis erythrothorax furtiva, subsp. nov.

Sixteen, ♂♂, ♀ ♀; Presidio and Motzorongo, February, March, April.

Type.— M. C. Z. 233,783. Adult ♂. Mexico: Presidio, Vera Cruz. 22 March, 1925. Wilmot W. Brown.

Characters.— Similar to *Synallaxis erythrothorax erythrothorax* Sclater (Coban, Guatemala, and Honduras) but median portion of abdomen greyer, less whitish, and flanks more olive without any tinge of reddish.

Measurements of a considerable series fail to show any differences in size between the two forms.

Specimens examined: —

Synallaxis erythrothorax erythrothorax Sclater. Guatemala. Five, trade skins (not sexed). British Honduras. Two, ♂♂. Yucatan and Quintana Roo. One, ♀; one, not sexed.

Synallaxis erythrothorax furtiva nobis. Vera Cruz, Presidio, and Motzorongo. Fourteen, ♂♂; two, ♀ ♀. Pasa Nueva. One, ♂. Buena Vista. One, ♂. Tlacolalpan. One, ♂.

Automolus ochrolaemus cervinigularis (Sclater).

Nine, ♂♂, ♀ ♀; Presidio, March, May.

These are all dark olive-brown. Old museum skins are much redder above and there is, as in many cases in birds of somewhat similar color, a considerable change with age of the specimens.

Xenops minutus mexicanus Sclater.

One, ♂; Presidio, 29 March.

Sclerurus mexicanus mexicanus Sclater.

Two, ♂♂; Presidio, March, April.

DENDROCOLAPTIDAE.

Dendrocolaptes certhia sancti-thomae (Lafresnaye).

One, ♂; Presidio, 30 March.

Xiphorhynchus flavigaster flavigaster (Swainson).

Six, ♂♂, ♀♀; Presidio and Motzorongo, March, April, May.

Sittasomus griseicapillus sylvioides Lafresnaye.

Four, ♂, ♀♀♀; Presidio and Motzorongo, March.

Dendrocincla anabatina anabatina Sclater.

One, ♀; Presidio, 18 February.

TYRANNIDAE.

Platytriccus cancrominus (Sclater and Salvin).

Two, ♀♀; Presidio and Motzorongo, February, April.

Craspedoprion brevirostris (Cabanis).

Two, ♂, ♀; Presidio, 4 March, 20 May.

Rhynchocyclus cinereiceps Sclater.

One, ♀; Motzorongo, 10 February.

Oncostoma cinereigulare (Sclater).

Two, ♂♂; Presidio, 27 March, 1 May.

Pipromorpha assimilis assimilis (Sclater).

Four, ♂♂♂, ♀; Presidio, March, April, May.

Leptopogon pileatus pileatus Cabanis.

One, ♂; Presidio, 21 April.

Elaenia flavogaster subpagana Sclater.

One, ♀; Presidio, 27 April.

Myiozetetes texensis texensis (Giraud).

Four, ♂, ♀♀♀; Presidio and Motzorongo, February, March, May.

Pitangus sulphuratus derbianus (Kaup).

Six, ♂♂, ♀♀; Presidio and Motzorongo, February, March.

ONYCHORHYNCHUS MEXICANUS MEXICANUS (Sclater).

One, ♂; Presidio, 21 April.

MYIOBIUS XANTHOPYGUS SULPHUREIPYGIUS (Sclater).

Nine, ♂♂, ♀♀; Presidio and Motzorongo, February, March, April, May.

EMPIDONAX MINIMUS (W. M. and S. F. Baird).

Four, ♂♂♂, ♀; Presidio and Motzorongo, February, March.

EMPIDONAX FLAVIVENTRIS (W. M. and S. F. Baird).

Two, ♀♀; Presidio, 3 February, 22 March.

MYIOCHANES PERTINAX PERTINAX (Cabanis and Heine).

One, ♀; Motzorongo, 27 February.

MYIOCHANES RICHARDSONII SORDIDULUS (Sclater).

Four, ♂♂♂, ♀; Presidio and Motzorongo, February, May.

MYIARCHUS CRINITUS CRINITUS (Linné).

Two, ♂♂; Motzorongo, 9, 22 February.

MYIARCHUS LAWRENCEII LAWRENCEII (Giraud).

Two, ♂, ♀; Presidio and Motzorongo, 10 March, 1 February.

TYRANNUS MELANCHOLICUS COUCHII Baird.

One, ♂; Presidio, 20 February.

COTINGIDAE.

TITYRA SEMIFASCIATA PERSONATA Jardine and Selby.

Three, ♂, ♀♀; Presidio, March, April.

PACHYRHAMPHUS MAJOR MAJOR (Cabanis).

One, ♀; Presidio, 2 April.

LATHRIA UNIRUFA UNIRUFA (Sclater).

One, ♂; Presidio, 26 March.

HIRUNDINIDAE.

Stelgidopteryx ruficollis ridgwayi Nelson.

Two ♂♂, in winter plumage, Motzorongo, 11, 15 February, are extreme examples of this large, dark form, the exact limits of whose range are still unknown.

Measurements.

No.	*Sex*	*Wing*	*Tail*	*Tarsus*	*Culmen to base*
233,622	♂	119	41	12	11
233,623	♂	117	37	13	11

A male bird, M. C. Z. 102,962 from Texolo, Vera Cruz, Mexico, taken 6 March, 1899, has a wing of 113 mm. and is in color as well as size intermediate between *S. r. serripennis* (Audubon) and *S. r. ridgwayi* Nelson, though nearer the latter.

All Rough-winged Swallows are strictly representative forms and intergrade one with another, as well as by individual variation. Ridgway was quite wrong when he gave as an alternative in his key to the forms, some of which he treated as species, "without dusky spots at ends of longer undertail coverts" for *serripennis* and "with dusky spots at ends of longer undertail coverts," for the other forms. In the M. C. Z. series of seventy-four skins of *S. r. serripennis* (Audubon) from north of the Mexican-United States boundary line no less than sixteen examples have well-marked dusky spots at the ends of the longer undertail coverts, and some others have indications of such spots. Such examples, moreover, come from a number of different places scattered throughout the breeding range of the form, namely:— Georgia, Alabama, West Virginia, District of Columbia, Kansas, Colorado, California, Washington, and British Columbia. It is thus evident that the northern form has not wholly lost this character.

The immature specimen from Vera Cruz which Sclater named *fulvipennis*, "Wing, 3.7 inches," is assumed by Ridgway, probably correctly, to have been a young *S. r. serripennis* taken on migration. At one time the senior author used Sclater's name for the intermediate form, which ranges from Guatemala to Chiriqui, and was afterwards named *S. salvini* by Ridgway. This form is intermediate between *S. r. serripennis* and *S. r. uropygialis* (Lawrence), and, like the former, sometimes has the dusky spots at the ends of the longer undertail coverts and sometimes lacks them.

TROGLODYTIDAE.

Heleodytes zonatus zonatus (Lesson).

Thirteen, ♂♂, ♀♀; Presidio and Motzorongo, February, March, April, May.

Pheugopedius maculipectus maculipectus (Lafresnaye).

Ten, ♂♂, ♀♀; Presidio and Motzorongo. February, March, April, May.

Troglodytes aedon parkmanii Audubon.

One, adult ♀; Presidio, 15 March.

Henicorhina prostheleuca prostheleuca (Sclater).

Twenty-five, ♂♂, ♀♀; Presidio and Motzorongo, February, March, April, May.

This material shows that the form of *Henicorhina prostheleuea* occurring in Guatemala south to eastern Costa Rica, hitherto regarded as identical with true *prostheleuca* of southern Mexico, really represents a distinct race.

Henicorhina prostheleuca tropaea, subsp. nov.

Type.— M. C. Z. 121,443. Adult ♂. Costa Rica: La Vijagua, 25 February, 1908. C. F. Underwood.

Characters.— Similar to *Henicorhina prostheleuca prostheleuea* (Sclater) of Vera Cruz, (type locality Cordova), Mexico and of about the same size, but pileum, central crown stripe, more reddish, less greyish brown; back and scapulars much brighter brown, almost chestnut; chest and breast more purely white, less greyish white; and flanks, crissum, and undertail coverts much brighter, almost amber-brown. Similar also to *H. p. pittieri* Cherrie of extreme southwestern Costa Rica, (Type locality Boruca and Terraba), and western Panama, but slightly smaller and with pileum duller (chestnut-brown to chestnut in *H. p. pittieri*); back, rump, and wings duller, less intensely reddish brown; chest and breast equally pure white.

Range.— Eastern and northern Costa Rica northwards to Guatemala. (Birds from so far north as Guatemala seem better referred here, than to true *H. prostheleuea*, which in its extreme form is restricted to southern Mexico).

Measurements.— Adults only. Sexes apparently similar in size.[1]

Henicorhina prostheleuca prostheleuca (Sclater). Mexico (Vera Cruz, Motzorongo, Presidio, Orizaba and Buena Vista). Wing, 52 (50–57); tail feathers, 23.8 (20–28); tarsus, 21.7 (21–23); culmen to base of forehead, 16.5 (16–18). Thirty-one specimens.

Henicorhina prostheleuca tropaca nobis. Costa Rica (Tenorio, Cerro Sta. Maria, La Vijagua, Juan Vinas and Carrillo). Wing, 53.1 (50–57); tail feathers, 21.9 (20–25); tarsus, 22.6 (21–24); culmen to base of forehead, 17.2 (16–19). Seventy specimens.

Henicorhina prostheleuca pittieri Cherrie, Southwest Costa Rica (Boruca, El General, Buenos Aires and Lagarto). Wing, 58 (56–61); tail feathers, 26.2 (22–31); tarsus, 22.8 (21–25); culmen to base of forehead, 18 (16–19). Nineteen specimens.

Hylorchilus sumichrasti (Lawrence).

Thirty-eight, ♂♂, ♀♀; Presidio, March, April, May.

Sumichrast's Wren is one of the rarest and most local of all North American birds, previously known only from three specimens. It formed the special object of Brown's visit to the region.

Writing under date of 19 April, 1925, Mr. Brown says,

> Have a nice series of the Wood Wren, *Hylorchilus sumichrasti*. *Had hard* work to find it. I hunted thoroughly in the locality where Nelson said he took his but without success. It is a very interesting looking wren and to me it looks like a giant Winter Wren. It is nearly the size of a Cactus Wren and is very local in its distribution.

In another letter a month later he writes,

> Discovered a new collecting ground for the wren where my guide and I collected 18 specimens and a fine set of eggs. The nest was located in a crevice in the roof of a cave. The cave was high up in the mountains in the thick primeval forest where there had been a tremendous upheaval in the past, for the slope was wild, rough and broken — immense rocks as large as a fair-sized house had to be climbed and deep, pit-like depressions avoided.

In addition to the set of eggs mentioned, Brown sent in the nest from which they were taken and two other nests without eggs. In all cases the nests are bulky, composed of soft material, grasses, rootlets, leaves, and moss, thickly lined with plant down, feathers, and in one a large piece of rabbit's fur.

Nest **1** contained three white eggs measuring 23 x 17; 23.5 x 17;

[1] In the large series measured, no differences were noted in size correlated with sex as determined by the collectors of the specimens.

23.7 x 17 mm. "Nest and eggs were taken near Presidio May 6, 1925, from a crevice in the roof of a cave in the primeval forest high in the mountains."

Nest 2. "Nest in a crevice in the side of a large rock in shady, humid forest in the mountains. Contained three white eggs on the point of hatching,— too far gone to save. May 17, 1925. Altitude about 2000 feet?"

Nest 3. "— in a crevice in the side of a large rock high up in the mountains, in shady, humid, primeval forest. Contained three white eggs too far advanced to save. May 20, 1925. Alt. 2000??"

From the above it will be seen that Sumichrast's Wren is found in heavy humid forest, whose floor is strewn with large rocks, in the crevices of which the birds build their nests, laying normally three white eggs about the first of May.

Unfortunately Mr. Brown's letters do not give us any account of the habits or notes of this rare and extremely interesting species.

MIMIDAE.

Dumetella carolinensis (Linné).

One, ♂; Presidio, 21 March.

POLIOPTILIDAE.

Polioptila caerulea caerulea (Linné).

One, ♂; Motzorongo, 29 January.

TURDIDAE.

Turdus grayi grayi Bonaparte.

Eight, ♂♂, ♀♀; Presidio and Motzorongo, February, March, April, May.

Hylocichla ustulata swainsoni (Cabanis).

One, ♂; Presidio, 6 May.

VIREONIDAE.

Vireosylva flavoviridis flavoviridis Cassin.

Five, ♂♂♂♂, ♀; Presidio, April, May.

VIREOSYLVA PHILADELPHICA Cassin.

Two, ♂♂; Presidio, 10 May.

VIREOSYLVA GILVA SWAINSONII (Baird).

One, ♀; Presidio, 4 May.

VIREO GRISEUS GRISEUS (Boddaert).

One, ♂; Presidio, 9 March.

VIREO BELLII BELLII Audubon.

One, ♀; Presidio, 6 May.

PACHYSYLVIA DECURTATA DECURTATA (Bonaparte).

One, ♂; Presidio, 21 April.

The form inhabiting Costa Rica and Panama is considered valid and recognized under the name of *P. d. pusilla* (Lawrence). It differs from true *P. d. decurtata* (Bonaparte) (Type locality Guatemala) in being more yellowish green on the back, crown paler grey and less sharply defined posteriorly.

Size is not a constant character on which to base a separation in this species, since measurements of specimens from Vera Cruz to southern Costa Rica are fairly constant. Two males from Panama are smaller, but in both cases the sexing cannot be relied upon, since two "females" from Panama are larger than either of the "males."

PACHYSYLVIA OCHRACEICEPS OCHRACEICEPS (Sclater).

One, ♂; Presidio, 29 April.

VIREOLANIUS PULCHELLUS PULCHELLUS Sclater and Salvin.

One, ♂; Presidio, 30 April.

CYCLARHIS FLAVIVENTRIS FLAVIVENTRIS Lafresnaye.

Three, ♂♂; Presidio and Motzorongo, February, March, May.

MNIOTILTIDAE.

MNIOTILTA VARIA (Linné).

One, ♀; Motzorongo, 1 February.

Dendroica magnolia (Wilson).

Two, ♀ ♀ ; Presidio, 22 March, and Motzorongo, 1 February.

Dendroica virens virens (Gmelin).

One, ♂; Presidio, 15 March.

Seiurus noveboracensis notabilis Ridgway.

One, ♀ ; Presidio, 21 May.

Icteria virens virens (Linné).

Two, ♂♂; Presidio and Motzorongo, 26 March, 27 February.

Wilsonia pusilla pusilla (Wilson).

One, ♀ ; Motzorongo, 7 February.

Setophaga ruticilla (Linné).

Three, ♂♂, ♀ ; Presidio and Motzorongo, 10 February, 9 March, 29 April.

Euthlypis lachrymosa lachrymosa Cabanis.

Two, ♂, ♀ ; Presidio, 6 March, 30 April.

Basileuterus culicivorus culicivorus (Lichtenstein).

Three, ♂♂, ♀ ; Presidio and Motzorongo, February, May.

FRINGILLIDAE.

Guiraca caerulea lazula (Lesson).

One, ♀ ; Presidio, 21 March.

Cyanocompsa cyanoides concreta (DuBus).

Two, ♀ ♀ ; Presidio and Motzorongo, February, March.

Cyanocompsa parellina parellina (Bonaparte).

Three, ♂♂, ♀ ; Presidio and Motzorongo, February, March.

Oryzoborus funereus Sclater.

One, ♀ ; Motzorongo, 7 February.

SPOROPHILA MORELLETI MORELLETI (Bonaparte).

Seven, ♂♂, ♀♀; Presidio and Motzorongo, February, March, May.

VOLATINIA JACARINI ATRONITENS Todd.

Two, ♂♂; Presidio and Motzorongo, 1 May, 25 February.

CARYOTHRAUSTES POLIOGASTER POLIOGASTER (DuBus).

Two, ♂, ♀; Presidio, 11 March, 12 May.

SALTATOR ATRICEPS ATRICEPS Lesson.

Nine, ♂♂, ♀♀; Presidio and Motzorongo, February, May.

SALTATOR MAGNOIDES MAGNOIDES Lafresnaye.

Three, ♂♂; Motzorongo, February.

SALTATOR GRANDIS (Lichtenstein).

One, ♀; Presidio, 25 March.

AIMOPHILA RUFESCENS RUFESCENS (Swainson).

One, ♂; Presidio, 27 March.

MELOSPIZA LINCOLNII LINCOLNII (Audubon).

Two, ♂♂; Presidio and Motzorongo, 2 February, 21 March.

PASSERINA CIRIS (Linné).

Four, ♂♂; Presidio, February, March, April.

ARREMONOPS RUFIVIRGATUS CRASSIROSTRIS Ridgway.

Three, ♀♀; Presidio and Motzorongo, February, March.

BUARREMON BRUNNEINUCHUS BRUNNEINUCHUS (Lafresnaye).

Two, ♀♀; Presidio, 25, 29 March.

The two specimens have dark brown crowns which we are unable to match in the M. C. Z. series from anywhere within its wide distribution. We thought at first that they might represent a new form confined to the extreme northeastern part of the range of the species, but a single specimen taken by Nelson and Goldman at Motzorongo, 5

March, 1894 (Adult male, 143,587 Coll. U. S. Biological Survey), and kindly loaned us, is similar to examples from other localities, and we are unable to account for the peculiar characters exhibited by the Presidio specimens, which do not, by the way, appear to be immature.

TANAGRIDAE.

Tanagra affinis Lesson.

One, ♀; Presidio, 21 May.

Tanagra gouldi (Sclater).

Two, ♂, ♀; Presidio, 14 April; Motzorongo, 7 February.

Thraupis abbas (Lichtenstein).

Four, ♂♂, ♀ ♀; Presidio, April, May.

Phlogothraupis sanguinolenta sanguinolenta (Lesson).

Twelve, ♂♂, ♀ ♀; Presidio and Motzorongo, February, March, May.

Piranga rubra rubra (Linné).

Three, ♂♂, ♀; Motzorongo, February.

Piranga leucoptera leucoptera Trudeau.

Two, ♂♂; Motzorongo and Presidio, 6 February, 10 March.

Habia salvini salvini (Berlepsch).

Thirteen, ♂♂, ♀ ♀; Presidio and Motzorongo, February, March, May.

Habia rubica rubicoides (Lafresnaye).

Ten, ♂♂, ♀ ♀; Presidio and Motzorongo, February, March, May.

Lanio aurantius Lafresnaye.

One, ♂; Presidio, 5 May.

ICTERIDAE.

Amblycercus holosericeus (Lichtenstein).

Five, ♂♂♂, ♀ ♀; Presidio and Motzorongo, February, March.

Tangavius aeneus involucratus (Lesson).

Five, ♂♂♂♂♂, ♀; Presidio and Motzorongo, February, March, May.

Icterus spurius (Linné).

One, ♀; Presidio, 21 March.

Icterus mesomelas mesomelas (Wagler).

Two, ♂♂; Presidio, 18 February, 5 April.

Dives dives (Lichtenstein).

One ♂; Presidio, 21 March.

Megaquiscalus major macrourus (Swainson).

Three, ♂, ♀♀; Presidio, March, April, May.

CORVIDAE.

Xanthoura luxuosa luxuosa (Lesson).

Two, ♂♂; Presidio, 19 February; Motzorongo, 2 February.

Psilorhinus morio fuliginosus (Lesson).

One, ♂; Presidio, 2 April.

Bulletin of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. LXVII. No. 16.

SOME HYDROIDS OF SOUTH CHINA.

By Charles W. Hargitt.

With Two Plates.

CAMBRIDGE, MASS., U. S. A.:
PRINTED FOR THE MUSEUM
May, 1927.

No. 16.— *Some Hydroids of South China.*[1]

By Charles W. Hargitt.

The material upon which this paper is based was received from several sources. Most of it was collected near Amoy by Prof. S. F. Light and Mr. Arthur Campbell, but a part of it had been sent to Dr. Elof Jäderholm, who in turn sent it to Dr. E. Stechow. Knowing my paper on the Hydroids of the Philippine Islands (1924), Dr. Stechow sent it to me. Both Professor Light and Mr. Campbell urged that I accept their material. For this generosity I tender sincere thanks; likewise to the late Prof. C. C. Nutting acknowledgement is made for the courtesy of comparing certain specimens with the types of his own species.

Mr. Campbell's pertinent note follows: —

"During a period of two years spent in Canton, China, opportunity was offered to collect a number of littoral marine animals of South China. . . . Practically nothing is known of the hydroids of the southern part of China, and very little indeed of the north. The coast of South China is characterized by extensive mud-flats and wide bays, into which deep rivers have cut out channels. In many places there are numerous islands, some of volcanic rock, some of granite. Most of the specimens in my collections have been taken among the rocky tide-pools and caves on these islands. . . . The absence of large areas of laminarian seaweeds is to be noted. The coasts of China are frequently visited with destructive storms which sweep away many of the familiar habitats of these animals, and often all places even slightly exposed are swept clean of animal life. It is then possible to find littoral forms only in caves or sheltered tide-pools along leeward sides of islands and the mainland."

Hydra vulgaris Pallas.

Campbell refers a number of imperfect specimens to this species; concerning these he wrote:—

"A few specimens of what appear to be typical members of this species have been taken every spring at Amoy, and are used there by members of the University for teaching and research. Those examined by me were preserved and rather shrunken, but they agree with the published descriptions of the species in all respects except that the tentacles are a little shorter than in most accounts. Hence they can be positively identified as the species *vulgaris*.

[1] Contribution from the Zoölogical Laboratory of Syracuse University.

Later specimens were captured in ponds near the college at Canton.

In color the specimens are white (alcoholic). Tentacles number about seven. They were found growing on the stems of various green plants."

Dr. Bedot's paper (Zool. anz., 1912, **39**, p. 602–604) deals with the complicated synonomy of the species of Hydra.

Bimeria Wright.

Trophosome.— Hydrocaulus erect, branching, with stoloniferous hydrorhiza; hydranths fusiform, or in contraction subspherical. Perisarc usually opaque from the presence of dark, granular mineral matters which cover the outer surface, extending over the basal portion of the hydranths, or in some cases extending over the proximal half of the tentacles.

Gonosome.— Gonophores are sporosacs of variable size and shape, and borne on pedicels arising from stem or branches.

Torrey's reasons (Univ. Calif. publ. Zool., 1902, **1**, p. 26) as to the relation of Bimeria and Garveia and their inclusion in Bougainvillidae are valid and convincing.

Bimeria amoyensis, sp. nov.

Figure 1.

Cf. Clarke, Trans. Conn. acad., 1876, **3**, p. 252. Nutting, Proc. Wash. acad., 1901, **3**, p. 166. Torrey, Univ. Calif. publ. Zool., 1902, **1**, p. 26; 1904, **2**, p. 6.

There were two lots containing colonies of a hydroid which partook of characters shared in common by several genera, *e. g.* Bimeria, Garveia, and Perigonimus. Those from the first were devoid of gonophores, which left much doubt as to their affinities. Other colonies in the second lot, fortunately bearing gonophores, showed that their proximal relations were with Bimeria, the numerous sporosacs assuring this. Following are distinctive characters:—

Trophosome.— Stems erect from creeping stolons, branching much as in Eudendrium, with heavy ovoid or spindle-like hydranths, bearing short thick tentacles; colony with rather dense opaque perisarc distinctive of the genus; height 10–15 mm. Tentacles apparently a single cycle, ten to twelve in number, upon the bases of which perisarc extended, forming also a bowl-shaped theca about the hydranth base or in some cases half the body.

Gonosome.— Gonophores are sporosacs, borne on short pedicels of stem or branches singly; male elongate, cylindrical, three or four times the diameter varying as to state of development: female ovoid, specimens poorly preserved.

Browne (1907) has described two new species of Bimeria dredged from the northern side of the Bay of Biscay in August 1906 from depths of more than 400 fathoms. The type species, *B. vestita* Wright, was also taken at a depth of seventy-five fathoms. In both these species the stems are described as fascicled, a feature not described of those earlier known. Concerning *B. biscayana* Browne remarks of the gonosome (reported as unknown) that "as the Hydroid was found at

Fig. 1.— Bimeria amoyensis Hargitt.
G. T. H., del. 1/100 mm.

a depth of over 400 fathoms, its gonophore is almost certain to be a sporosac." This inference is not obvious, for numerous hydroids of shallow waters, such as Clava, Eudendrium, Cordylophora, are exclusively of the sporosac type, as is that here described taken from shallow waters.

Tubularia Linné (in part).

Trophosome.— Hydrocaulus comprising simple or branching colonies of hydroids borne by stoloniferous or reticulate hydrorhiza. Hydranths generally flask-shaped, sharply differentiated from the stem, tentacles comprise two series — a basal or proximal series, larger than the oral or distal series. Usu-

ally both of these are comprised of simple filamentous organs arranged in cycles or whorls. The basal surrounding the base of the polyp, the oral surrounding the mouth of the polyp; both these series are usually simple, the latter often in two or more series making up closely articulated whorls.

Gonosome.— The reproductive organs form sporosacs which are borne upon branched stems or peduncles, forming clustered or raceme-like masses arising from the body of the hydranth between the two series of tentacles. These reproductive organs are medusoid in form, but never become detached from the body of the hydranth. Development takes place within these medusoids, the shape and character of which may be often recognized in their form. The embryos are liberated as larvae known as actinulae.

Tubularia mesembryanthemum Allman.

A fine colony of this hydroid was taken from the bottom of a Chinese junk in March 1924 by Messrs. Wu and Yuh at Amoy. The specimens were preserved in 10% formalin and as a consequence, while preserving the specimens satisfactorily, many of the hydranths had fallen from the stems when the collection was received and thus they were more or less injured.

Trophosome.— The colony large and complexly connected by a reticulated rhizocaulus; hydrocaulus is of the usual type, stems mostly simple or sparingly branched, bearing at the summit the large flask-shaped polyp, each stem reaching a height of 35 to 50 mm. Hydranths large and with the usual two series of tentacles, the basal large, filiform, tapering to an acute point and numbering from about twenty to twenty-five. The distal or oral series about the same, but are relatively short, apparently contracted by the preservative.

It may be noted in this connection that little taxonomic importance can be attached to the number of tentacles, as this varies greatly in different specimens, depending upon their age and size.

In a species described by Inaba (1890), and designated by Stechow (1913, p. 52), as *Tubularia mesembryanthemum*, tentacles are stated to be, oral ten, basal twenty. The specimens described must have been quite immature, as the specimens under consideration average twice that. I can distinguish no other incompatibility between the specimens here described and those of Inaba and Stechow, except that of the numerical differences in these organs, an entirely inconsequential difference.

Gonosome.— Medusoids borne in raceme-like clusters from the body of the hydranth just above the circle of basal tentacles. In form the medusoids are barrel-shaped, about twice as long as broad and resemble very much those of

the familiar *Tubularia crocea*, though apparently rather more degenerate. Actinulae were easily distinguishable within the bell-cavity of the sporosacs.

I studied this species at Naples, following its life history throughout and including in some detail the embryology as well as the morphology.

Tubularia spherogonia, sp. nov.

Two lots were collected at Amoy, on rocks at low tide, by Mr. Light whose care in their preservation left nothing to be desired. The colonies were made up of a complex mass of reticulate stolons and stems, the latter usually devoid of branches.

Trophosome.— Stems simple or rarely branched, erect, from 20–40 mm. high; perisarc rather delicate, with occasional annulations at base, and sometimes at about middle, and often with a distinct series at the upper end, and apparently constricting the apex. Hydranths large, flask-shaped, and with the usual basal series of filiform tentacles, twenty to twenty-five in number, large, but tapering to acute tips; the oral series delicate, forming a close whorl about the mouth, in number the same as the basal series. The number varies with size and maturity of the polyp.

The hydrorhiza is complete, forming an intricate network resulting in a dense colonial mass characteristic of tubularians.

Gonosome.— The medusoids are mere sporosacs (male), very numerous, borne in series, on short pedicels, and subspherical, with merely rudimentary tentacular buds. Manubrium and marginal canal distinguishable, but radial canals apparently absent.

This hydroid is an interesting one, especially in the shape of the medusoids; all those known to the writer being ovoid elongate, and with organization quite distinctly medusoid; the name proposed designating the unusual shape of the gonophores.

Hybocodon Agassiz.

Trophosome.— This consists of a simple hydrocaulus, arising from a stolon-like hydrorhiza. Hydranths flask-shaped, sharply demarcated from the supporting stem; there are two series of tentacles, the aboral, long and filamentous, a single whorl about the base; the distal, or oral series forming two or more whorls about the mouth.

Gonosome.— Medusae are borne on peduncles which arise from the body of the hydranth between the basal and oral tentacles. At the period of liberation the medusae are bell-shaped, with a well-developed manubrium, four radical canals, and usually a single large tentacle produced from one of these, which results in an unsymmetrical shape of the bell.

Hybocodon amoyensis, sp. nov.

Plate 1, fig. 3. Figure 2.

In the collection was a most interesting specimen, taken by S. F. Light at a wharf near Amoy, October 24, 1922. It was among the specimens of Athecata which Mr. Arthur Campbell had studied, and designated as a new species of Tubularia. My investigations made it evident that not only is the species new, but that it belongs to Hybo-

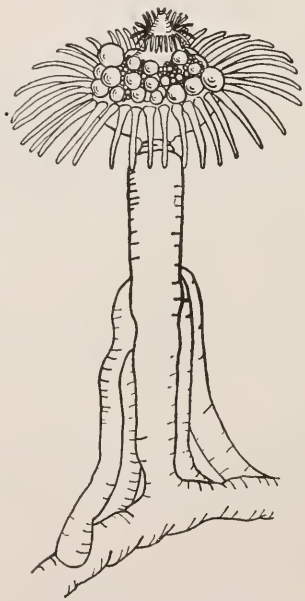

Fig. 2.— Hybocodon amoyensis Hargitt.
A. C., del. About 5 times.

codon. The hydroid characters, coenosarcal canals of the stem, the perisarc, and the medusoids were of such maturity as to show distinct asymmetry, and the single large tentacle revealed its Hybocodon affinities. In size, aspects of structure, etc. it strongly resembled the typical characters of *H. prolifer* of L. Agassiz. But it has also features which distinguish it from that species, notably the peculiar supporting braces which are well shown in both the sketches and photographs of

Campbell's account. Other features are specified in the following description by Mr. Campbell:—

"The lower part of each main polyp-bearing stem is buttressed with from two to four auxiliary stems which originate independently from the hydrorhiza, but close by the base of the main stem, and unite with the latter at varying levels. As a rule the union occurs at about one third the height of the main stem, seldom much below that level; sometimes, however, as high as two-thirds as far up as the height of the stem. In most cases these auxiliary stems are less in diameter than the main stem; but in some specimens almost equally stout. In examples with two auxiliary stems these unite with the main stem at the same level. Where there are more, this is the case with the outermost pair, but the inner ones may be united just below the other pair. In all cases these auxiliary stems originate from the hydrorhiza close to the base of the main stem; the inner ones form a short basal bridge and lie in close contact with the latter throughout their entire length up to the point of junction. There are never more than two pairs. The outer pair are in close contact with the inner ones. Neither the main stem nor the basal auxiliary stems are ever branched. But both the main and auxiliary stems are closely ringed throughout their length with exceedingly narrow annulations."

This description with the exception of the last sentence or two is correct. As to the last statement, I find no evidence of annulation of the perisarc of these structures, and the account of the tentacles is also defective. Careful dissection under the microscope shows that in an average-sized specimen the basal tentacles average thirty-six, and the oral tentacles are in two series and with a total average of about eighty.

Of the gonophores Campbell states that they are "sporosacs," but a more critical examination would have shown them to be medusae, and further that these were unsymmetrical, which takes the hydroid out of the Tubularidae, or at least out of Tubularia, and allies it at once with Hybocodon.

But in spite of these rather marked contrasts, there remain strong points of likeness. Matters of size are often mere expressions of conditions of environment of similar influences. The most obvious feature of distinction is the presence of the auxiliary buttresses described by Campbell and shown in Plate 1, fig. 3. The presence of stoloniferous accessories are well known in many hydroids, some of which may serve as support, as in the present case. May it not be probable that those so conspicuous here are provisions of the organism to meet a possible emergency involved in the somewhat local habitat, namely, the exposure to all sorts of surroundings and exigencies of the wharf or pier, subjecting the specimens to the surge and swash incident to such a con-

dition? In such an environment solitary polyps unused to such exposure might well develop such braces as stays or props to support the large hydranths. A single case could hardly call out such a unique and unusual expression of adaptation, but if, as mentioned by Campbell, the region is liable to the frequent storms he describes, the performance may have come into use as a consequence. This is only a tentative suggestion, but is made as a reason for future observation when collecting in such unusual situations. In the original description of *H. prolifer* by L. Agassiz emphasis was given to the habitat in which they were found, namely, deep and pure waters and where there was protection from heavy waves (*Cf.* Contrib. nat. hist. U. S., 1862, **4**, p. 243). Specimens of this hydroid have been taken by collectors at the U. S. Fisheries Laboratory, Woods Hole, and the medusae occur in abundance during the spring and summer at Woods Hole, and off Nantucket and Crab Ledge. From these medusae, bearing eggs and larvae in all phases of development, I am able to correct some incidental errors of the original description of Agassiz, such for example, that young medusae "arise singly on very short peduncles direct from the body of the parent hydranth." On the contrary medusae arise on peduncles which branch, producing numerous medusae, as in Tubularia and Ectopleura, but never in dense and pendulous racemes characteristic of the Tubularidae.

These observations are also true of the species from Amoy, as shown in Figure 2, and Plate **1**, fig. 3. However, the medusae appear in succession and not in vast numbers as in many other tubularian hydroids.

Trophosome.— This comprises a series of more or less independent hydroids, borne from a creeping hydrorhiza which may branch, and, at intervals, give rise to other polyps, thus forming a sort of colony of more or less detached individuals.

These are very similar to those of *H. prolifer*, as described by Agassiz (1862, **4**, p. 244, pl. 25) but are smaller. For example, *H. polifer* averages 50 mm. in height, while *H. amoyensis* only 20 mm. In the former the stems are about 1 mm. in diameter at the base and 2 mm. at the top; while in the latter they are 7 mm. at the base and 2.1 mm. at the top.

Hybocodon prolifer has its habitat only in purest sea-water, and in pools protected from heavy waves, from which it was inferred that in general it was of deep water habit, and later facts sustain this view. In the present species the habitat seems very different — among marine organisms on a wharf, a habitat likely to be subject to pollution and more or less buffeting by waves.

So far as certainly known *Hybocodon prolifer* has not been found beyond its original habitat, viz. the coast waters of Massachusetts Bay, and adjacent localities.

Bonnevie (1899, p. 28) has described a hydroid, *Tubularia prolifer*, but the description leaves serious doubt as to its identity. Both in the descriptive account and figures it has distinctive tubularian features, rather than those of Hybocodon; the medusa, however, has closer resemblance to that of Hybocodon.

Browne (1905, p. 752) has recorded the occurrence of the medusae in Loch Ranza, Arran, 1901, during April and May, and in 1902, April 3 to June 11. He states that "The hydroid *Hybocodon prolifer* has not yet been found in British waters. To judge from the abundance of the medusa and the presence of free-floating actinulae, the hydroid is almost certain to live in the Firth of Clyde, probably in the neighbourhood of Arran."

Hartlaub (1907, p. 98, 102, 103) describes the distribution of the medusae, and designates Bonnevie's *H. prolifer* as a new species, *Hybocodon christinae*.

H. B. Bigelow (1913, p. 6) notes the occurrence of the medusae of a *Hybocodon* believed to be *prolifer* in Dutch Harbor, Northwestern Pacific, 1908. He briefly reviews the distribution of both the hydroid and medusa, including his own finding as above,— "The Hybocodons of the fisheries Steamer Albatross collection can be identified only provisionally, until the hydroid is known. But as the medusae agree perfectly well with *prolifer* they are referred to that species."

Eudendrium Ehrenberg (in part).

Trophosome.— This comprises a plant-like hydrocaulus, more or less symmetrical, borne from a creeping stoloniferous hydrorhiza. Hydranths oval or flask-shaped, with the hypostome expanded into a trumpet-like proboscis; a single series of tentacles, filaments in shape, surrounds the base of the hydranth.

Gonosome.— Sporosacs are developed from the body of the hydranth or from the hydrocaulus. Male sporosacs usually form a cycle of bead-like filaments around the base of the hydranths; female sporosacs appear singly, the contained egg being easily distinguishable by the microscope.

Eudendrium californicum Torrey.

Plate 1, fig. 4.

Eudendrium californicum Torrey, Univ. Calif. publ. Zool., 1902, **1**, p. 32. Fraser, Bull. Lab. nat. hist. State univ. Iowa, 1911, **6**, no. 1, p. 24. Trans. Roy. soc. Canada, 1914, **8**, p. 121.

Mr. Campbell collected a good example of this species, of which he has made the following record:—

"It agrees closely with *Eudendrium californicum* Torrey. The species resembles *Eudendrium vaginatum* Allman closely, but differs in that the annulae are distinctly narrower about the stem and branches, and in the general habit which is free and graceful.

Trophosome.— The stems are stout, simple and erect, reaching a height of about 140 mm. in a mature colony. Each stem ascends in a loose spiral, giving rise to branches at frequent intervals in all planes. Hydranths usually with about 20 tentacles, borne on secondary branches. Color in life flesh-pink. Intertwined among the branches of this colony are typical specimens of *ampanularia urceolata* Clarke, common in California and at Hong Kong."

Eudendrium pusillum amoyicum, var. nov.

Plate 1, fig. 1.

Specimens of this form were found among a mass of various hydroids, Obelia, Plumularia, etc., Algae, and Bryozoa. They have features both of structure and habitat quite like that of *E. pusillum* Lendenfeld (1885, p. 352) of Australia.

Trophosome.— Colonies comprise a creeping hydrorhiza, hydrocaulus erect, profusely branched somewhat irregularly, and rising to a height of 10–15 mm., irregularly and sparingly annulated, branches with two or three rings at base and terminus. Hydranths of typical shape, with trumpet-shaped proboscis, relatively large and with twelve to twenty tentacles.

Gonosome.— Only female gonophores were present and only in a few specimens. They arise on the body of hydranths as in many well-known species, and as a result the polyps early atrophy as in other species, in many cases leaving the gonophores in clusters on the terminus of branches. Another type appears to arise singly on short pedicels of branches as is also common in other species.

In the small size of colonies and physical aspects of the trophosome the species differs from most other small species known, but resembles most closely that named above, and with varietal features such as to

suggest a new name. In later collections it may be found to be entitled to distinct specific rank.

A specimen of *E. pusillum* from Australia, is devoid of gonophores and so leaves some doubt as to its specific identity with von Lendenfeld's species, though indicating the possibility of specific distinctness, or certainly varietal difference for localized distribution.

Pennaria australis Bale.

Cat. Austr. zoophytes, 1884, p. 45. Lendenfeld, Proc. Linn. soc. N. S. W., 1885, **9**, p. 593. Cat. Medusae Austr. seas, 1887, pt. 2, p. 34. Bedot, Rev. Suisse, 1916, **24**, p. 169.

Pennaria rosea Lendenfeld, Proc. Linn. soc. N. S. W., 1885, **9**, p. 594, pl. 24, fig. 40–42. Cat. Medusae Austr. seas, 1887, pt. 2, p. 34. Bale, Proc. Linn. soc. N. S. W., 1888, ser. 2, **3**, p. 747. Mayer, Medusae of the world, 1910, **1**, p. 27.

Mr. Campbell collected this species, though the specimens which came under my notice were fragmentary and undeveloped. Some years ago I received from Adelaide, Australia, fine specimens which had been taken in the height of the growing season, the trophosomes large, perfect, and bearing medusae in all stages of maturity. In the same collection there were hundreds of free medusae, and eggs in various stages of development which had been taken with tow-nets. Of these I gave some account in the Journal of morphology, 1911, **22**, p. 498. The specimens conformed perfectly with the original description of Bale, but had little in common with von Lendenfeld's original description of *P. rosea*, with which various attempts have been made to identify it, and to give that author a priority of description, though *he* did not at any time, so far as I know, make such claim. Further he recognized Bale's species and listed it prior to his own species, *P. rosea*. Therefore both in fact and in order of description *P. australis* must stand, as it does in the above table of synonomy taken from the Revue Suisse de Zoologie, 1916, p. 169, as the accepted status of the species.

Pennaria tiarella McCrady.

Pennaria tiarella McCrady, Proc. Elliot soc. nat. hist., 1858, **1**, p. 153.

Mr. Campbell states:—

"That this very common American hydroid is represented in my collection by a single specimen from Hong Kong. Its stems arise from a common stolon

and the longest are about 125 mm. long, each main stem branches alternately giving rise to branches of which the oldest are nearest the stock. The side branches may give rise to slightly branched polyp-bearing ramuli on their upper sides. These are annulated at the base with about six or seven rings, and the main stem and branches are annulate beyond each node with an equal number of rings, etc."

Specimens of this hydroid are in the collection made by Professor Light which, though they are rather fragmentary, are identified as this species. The specimens lacked gonophores and apparently were in a state of regeneration following hibernation (?). Having already recorded the occurrence of the species in Philippine waters (Hargitt, 1924, p. 475), this further record shows it to be widely distributed in both Atlantic and Pacific Oceans.

Campanularia Lamarck (in part).

Trophosome.— Colony simple or branched; hydrothecae distinctly campanulate.

Gonosome.— Gonangia are sporosacs, from which planulae emerge.

Campanularia urceolata Clarke.

Proc. Acad. nat. sci. Phil. 1876, p. 215. Nutting, Proc. Wash. acad., 1901, **3**, p. 172. Torrey, Univ. Calif. publ. Zool., 1902, **1**, p. 54. Fraser, Bull. Lab. nat. hist. State univ. Iowa, 1911, **6**, no. 1, p. 33.
Campanularia cylindrica Clarke, Trans. Conn. acad., 1876, **3**, p. 25.
Campanularia reduplicata Nutting, Proc. Wash. acad., 1901, **3**, p. 172.

Specimens of this interesting hydroid were found associated with a colony of *Eudendrium californicum* by Campbell at Hong Kong Harbor landing pier. It conforms closely with the descriptions of the above-named authors, though wholly devoid of gonosomes. Specimens agreeing quite closely with Torrey's description, especially with that of the unusual variability of the hydroid, may account for the several species designation made by earlier authors. It is worthy of note that so far as known the species is strictly symbiotic, always associated with other hydroids.

Clytia Lamouroux.

Trophosome.— In colonies, simple, or with branching stems, sometimes quite complex and of considerable size, hydranths usually flask-shaped and with

trumpet-like proboscis. Hydrorhiza usually a stoloniferous network spreading over the substratum.

Gonosome.— Gonangia producing bell-shaped medusae which have a small menubrium, four tentacles, and eight lithocists.

Clytia minuta (Nutting).

Campanularia minuta Nutting, Bull. U. S. F. C., 1901, **19**, p. 345.
Clytia minuta Fraser, Bull. Lab. nat. hist. State univ. Iowa, 1912, **6**, no. 3, p. 44. Nutting, Amer. hydroids, 1915, pt. 3, p. 61.

These specimens were taken at Amoy along with several species of hydroids, most of which were devoid of gonangia which renders precise

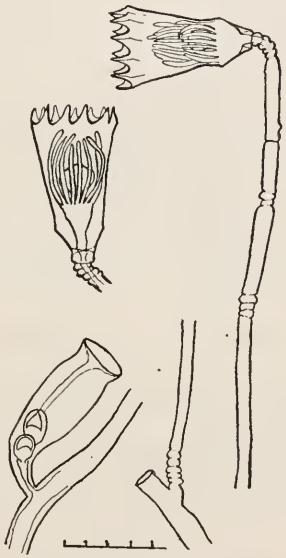

Fig. 3.— Clytia stechowi Hargitt.
G. T. H., del. 1/100 ×.

identity of species or genus doubtful. In this case, however, the species seems to agree in most respects with that described by Nutting with the following characteristics:—

Trophosome.— Hydrocaulus sparingly branched, arising from creeping stolons often attached to other hydroids; stems annulated at the base and at regular points above and again at the origin of the hydrotheca; branches also ringed at their base, but the stems not thus characterized. Hydrothecae obconi-

cal, about twice as long as broad at the orifice, and with ten sharp teeth, largest specimens 5–6 mm. high.

Clytia stechowi, sp. nov.

Figure 3.

Light's collection contained a small colony of a very minute campanularian hydroid which appears to be undescribed.

Trophosome.— Stems, simple, unbranched, with creeping hydrorhiza dark brown in color and dense in structure. Stems slender and delicate, annulated at base and apex, and usually two intermediate places, each bearing a single hydrotheca which is goblet-shaped, with a diaphragm, as in the genus generally, with about ten acute teeth; the hydranth of typical form and character. The whole about 5 mm. in height.

Gonosome.— Gonangia arise from the stolon, are slender and bear medusae of typical aspect (Figure 3).

The hydroid has apparently close relations to *C. clongata* of Marktanner-Turneretscher, (1890, p. 215), but differs in size and the character of hydrothecal teeth. It also resembles even more closely *C. ulvae* Stechow, (1919, p. 47–48), but again differs in size as the above. Again the absence of gonosome in each of them leaves the specific relations quite doubtful. It is a pleasure to name the species in honor of Dr. Stechow whose work in this field is so remarkable.

Obelia Peron and Lesuer.

Trophosome.— Colony plant-like arising from stoloniferous hydrorhiza; hydrothecae campanulate, with distinct diaphragm; hydranths somewhat flask-like with trumpet-shaped proboscis.

Gonosome.— Gonangia borne on stems and branches on the hydroid, in some species on the hydrorhiza also. Medusae disk-like with four radial canals, a four-lipped manubrium with numerous marginal tentacles which increase in number with growth.

Obelia gracilis Calkins.

Proc. Bost. soc. nat. hist., 1899, **28**, p. 353. Fraser, Bull. Lab. nat. hist. State univ. Iowa, 1911, **6**, no. 1, p. 39. Nutting, Amer. hydroids, 1915, pt. 3, p.78.

A single small colony was taken. In one respect there is a slight difference, namely the downward extension of the diaphragm, to which Calkins attaches some importance, as well as a support for the hydranth, though I cannot recognize it in this specimen. However, in the descriptions of Torrey and Fraser I do not find this point mentioned. It does not seem, therefore, an important feature. In other respects the

specimen compare very well with that of *O. gracilis*. This with certain others to be noted in other connections is interesting as showing identity of those from Chinese waters with those of the California coast.

Obelia everta, (?) sp. nov.

Figure 4.

This species is somewhat uncertain owing to the fact that the gonosome is lacking and therefore the decision of whether it is really new may be left for the future. Certain features, however, seem to strongly indicate such to be the fact.

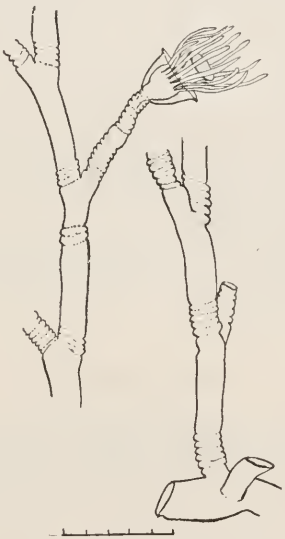

Fig. 4.— Obelia everta Hargitt.
G. T. H., del. 1/100 ×.

Trophosome.— Specimens are well developed about 20 mm. high, stems undulating or zigzag, with branches at each bend of a branch, with a variable number of polyps. Stems annulated just above each branch, the latter also usually completely annulated, ending in the cup-shaped hydrotheca which has smooth margins, and definitely everted rims. Hydranths typical in size, shape, and tentacles. Hydrorhiza comprised of creeping stolons which bear the stems and form attachments to the substrata. Some of the colonies are complexly branched with a most dense, dark-colored perisarc, and with stems in such cases less undulating than described above.

Gonothyraea Allman.

Trophosome.— Comparable with that of Obelia.

Gonosome.— Gonophores are medusoid sporosacs like imperfect medusae contained in gonangia quite similar to those of Obelia.

Gonothyraea inornata Nutting.

Proc. Wash. acad., 1901, **3**, p. 175. Fraser, Trans. Roy. soc. Canada, 1914, **8**, p. 149. Nutting, Amer. hydroids, 1915, pt. 3, p. 72.

Several colonies of this hydroid were collected by Light from rocks at Amoy, March, 1924, which in general features conform very well with those originally described by Nutting taken by the Harriman Expedition at Yakutat Bay, Alaska. They differ in certain details, but not such as would warrant establishing a new species; some of its peculiar features are: —

Trophosome.— Hydrocaulus slender, branching alternately, giving a distinctly geniculate aspect to the stem; height 15–25 mm. Hydranths of the usual size and shape, with about twenty filamentous tentacles. Hydrothecae goblet-shaped with smooth margins.

Gonosome.— Gonangia elongate obconical, smooth or with slightly annulated surface. Gonophores are sporosacs devoid of any medusoid features, and with only a single acrocyst in each, carrying several (four to six) embryos, which are liberated as planulae.

Halecium Oken.

Trophosome.— Hydrocaulus branching with biserial alternate hydrothecae. These are inconspicuous, for the most part comprising shallow, saucer-shaped hydrophores, borne on pedicels, or sessile upon branches or stems. In certain cases these hydrophores are ornamented with a circle of bright points just below their margins.

Gonosome.— Gonangia of these hydroids are dissimilar in the two sexes, the female often with a pair of hydranths borne from the orifice of the gonangium; male gonangia form mere sporosacs. The larvae of these hydroids escape as planulae, similar to those of Campanularia.

Halecium sessile Norman.

Rept. Brit. Assoc. for 1866, 1867, p. 205. Hincks, Brit. hydr. zoophytes, 1868, **1**, p. 229, pl. 44, fig. 2. Inaba, Zool. mag. Tokio, 1890. Jäderholm, K. Svenska vet. akad. Handl., 1909, **45**, no. 1, p. 58. Stechow, Abh. K. Bayer. akad. wiss. Math. phys. kl., 1913, **3**, suppl. bd., p. 86.

Trophosome.— The colonies are small, stems delicate, branching very irregularly; about 10 mm. in height, comprised of many short internodes. Hydrothecae sessile, small, opening just below each node with slightly everted mouth and devoid of any glistening points, or reduplications. Hydranths large and stout with about twenty tentacles. Rhizocaulus stoloniferous, somewhat reticulated.

Gonosome.— In these specimens collected October 24, 1923, gonophores were absent.

Halecium cymiforme Allman.

Rept. sci. results Challenger, 1888, **23**. Hydroida, pt. 2, p. 15. Stechow, Abh. K. Bayer. akad. wiss. Math. phys. kl., 1913, **3**, suppl. bd., p. 84. Inaba, Misaki hydroids, 1922.

A second species conforms quite well with Allman's *cymiforme*, except only in size. These specimens are much smaller, averaging only about 10 mm. in height. But in other features they are indistinguishable. The lack of gonangia is a further element of doubt to complete identity, though it agrees quite well with accounts and figures of Inaba. Gonosome lacking. In these specimens as in the preceding, I found no examples of reduplication of the hydrothecae to which Allman referred. And here, as in the former, there were no punctate, bead-like bodies as are found in many other species.

Halecium tenellum Hincks.

Brit. hydr. zoophytes, 1868, **1**, p. 226. Clarke, Trans. Conn. acad., 1876, **3**, p. 255. Nutting, Bull. U. S. F. C., 1901, **19**, p. 347. Jäderholm, K. Svenska vet. akad. Handl., 1909, **45**, no. 1, p. 55. Stechow, Zool. jahrb. Abth. syst., 1919, **42**, p. 41.

The third species in this series has the colony somewhat fragmentary, some creeping stolons, which tend to become reticulate. Stems very delicate, perisarc transparent, irregularly annulated; branches arise directly from the side of the stem just below a hydrotheca and by a sharp curve ascend vertically. Hydrothecae very shallow with everted margins entirely devoid of punctate bodies referred to in the preceding account. Another feature noted in the above descriptions namely, the prevalent reduplication of hydrothecae, common in many other species, is entirely lacking in these specimens. This with features of branching inclined me to believe that it might be a new species, but absence of gonosomes leaves the matter so uncertain that it seems better to regard

the differences as varietal; at least till other specimens finally warrant a more pronounced decision. Hydranths are of average size, with from twelve to sixteen tentacles. Gonosome absent.

Thuiaria Fleming.

Trophosome.— Stem erect, branching, arising from filiform stolons. Hydrothecae biserial on stem and branches, subopposite to alternate, usually more or less immersed in the hydrocaulus; with smooth margins or with one or two teeth, operculum with one or two valves.

Gonosome.— Gonangia usually ovoid, smooth or with one or two spines on the shoulders.

Thuiaria tubuliformis (Marktanner-Turneretscher).

Plate **2**, fig. 4, 5.

Dynamena tubuliformis Marktanner-Turneretscher, Ann. K. k. nat. hofmus., 1890, **5**, p. 238.

Thuiaria tubuliformis Nutting, Amer. hydroids, 1904, pt. 2, p. 70. Hargitt, Philipp. journ. sci., 1924, **24**, p. 493.

This collection contained several colonies of Thuiaria which on first inspection seemed to differ in specific features, especially the gonangia. Mr. Campbell's data gave the localities as "cave-rocks," Cheung, chau, at "sea-side" and on the shell of a living Mytilus, May 14 and 15, 1922.

Trophosome.— The stems arise from complex stolons, attain a height of 15 to 25 mm. sometimes irregularly and sparingly branched, opposite or alternate, when the latter the stems seem to show a geniculate aspect. Internodes usually bear two or more pairs of hydrothecae, but basal usually a single pair; modes at right angles to the axis and usually quite sharply marked. Hydrothecae subopposite, long tubular, and deeply sunk into the substance of stem or branch; the terminal portion abruptly turned outward ending in large paired teeth, which support a paired operculum. There is great variation as to the number and aspect of stems, length of internodes, etc. A very marked feature is that of the relation of the hydrothecae to branches and stems, namely, the branch at the base of an internode which bears it will have an even number of paired hydrotheca, the internode having an odd hydrotheca in the axis of stem and branch always attached to the stem.

Gonosome.— Gonangia differ rather sharply in the two sexes, a fact liable to lead one astray on first inspection, under the impression that it indicates a different species. The female gonangia in these specimens arise from the basal internodes, and directly from the orifice of hydrothecae, sometimes in pairs

and in other cases singly. They are also larger than the male gonangia; for example, an average female measured 155 microns in length, 65 microns in diameter; in the male the average length is 100 microns, the diameter 40 mm., they also differ in shape; the male being ovoid, the female elongate and spindle-like, in each an elongated neck, the margin of which is beautifully everted. The male gonangia arise from the base of hydrothecae, the adjacent region of the stem or branch.

Marktanner-Turneretscher's original material lacked gonangia, as did also that from the Philippines. Nutting described the gonangia, but apparently did not distinguish the sexual differences which led to my statement (1924, p. 493) "Nutting's figures are difficult to understand, since he gives three drawings of the gonangia, all different." I think the present account clears up what hitherto has been obscure, not to say somewhat misleading. As will be noted the specimens here described are much smaller than Nutting's described from several sources and also those from the Philippines (Hargitt, 1924, p. 493).

Pasythea Lamouroux (in part).

Trophosome.— Hydrothecae biserial, strictly opposite, arranged in pairs or series of pairs in groups upon a given internode, the upper pair usually smaller and differing in shape from the lower; margins bilabiate.

Gonosome.— Gonangia are oval or spindle-shaped, smooth or with rather broad annular rugosities with large openings.

Pasythea quadridentata (Ellis and Solander).

Plate **2**, fig. 1.

Sertularia quadridentata Ellis & Solander, Nat. hist. zoophytes, 1786, p. 57. Gmelin, Syst. nat., 1791, **1**, pt. 6, p. 3853. Lamarck, Hist. anim. sans vert., 1816, **2**, p. 121.

Pasythea quadridentata Esper Pflangenthiere, 1788, **3**, p. 237. Lamouroux, Hist. polyp. corall., 1816, p. 156. Bale, Cat. Austr. zoophytes, 1884, p. 112. Lendenfeld, Proc. Linn. soc. N. S. W., 1885, **9**, p. 419. Marktanner-Turneretscher, Ann. K. k. nat. hofmus., 1890, **5**, p. 234. Nutting, Amer. hydroids, 1904, pt. 2, p. 75, pl. 13, fig. 4–7.

Specimens taken by Prof. S. F. Light are in fine condition of maturity and preservation, with all stages of life history in typical perfection. In the following description these features will be shown and details not hitherto given noted at length, so far as discovered.

I described (1908, p. 114) an apparently new species, namely, *Pasy-*

thea nodosa, differing materially from that of earlier authors. No gonangia were present and until the specimens now under review were obtained I still held that the species was distinctly new. But this new material contains almost all known structural aspects of the species hitherto described of varietal nature, and reduces *Pasythea nodosa* to varietal rank. Stechow had (1913, p. 150) recognized the validity of *P. nodosa*, honoring it with the author's sketches. Billard in a critical paper (1924, p. 56) accorded recognition of the species, and in a later paper (1925, p. 96) gives it varietal rank.

In typical specimens the hydrocaulus arises directly from the stoloniferous hydrorhiza which creeps rather promiscuously over the frondose sea-weed which is apparently its normal habitat. Hydrothecae are often variable as to size, shape, and orifice. It is obvious that the specific name is based upon the presence of four thecal teeth. This is not always easy to recognize. Fraser states that these may be only two or three in number, though four is apparently typical.

Typically the stem is made up of basal internode with a single pair of hydrothecae; the second internode usually comprises two pairs of hydrothecae; the third with three pairs, then probably the fourth with four, with the following bearing three pairs, and last a terminal with two or perhaps a single pair of hydrothecae. The average internodes are about five, though not infrequently as many as eight, rarely nine or even ten are found. Rarely stems are branched as shown in (Hargitt, 1908, **14**, p. 116, fig. 15).

Gonosome.— In this collection are abundant gonangia and they show the typical generic aspects described by Bale (1884, p. 112). "Gonothecae smooth *or* transversely ringed." But in his account of *Pasythea quadridentata*, Bale states that he had "not met with the gonothecae" and that his "description of them is in accordance with Lamouroux' figure." As will be seen (Plate **2**, fig. 1) there is considerable variation in shape and size, yet there is a typical average. And it will be noted that there is not the deep and sharp corrugations shown in figures of Nutting (1904, pl. 13, fig. 5; and Fraser, 1912, fig. 35), that some are devoid of annulations. Usually there is a single gonangium on a stem, borne at its base; but rarely have I found two such rising close together on the base as will be noted in some of the figures.

Habitat.— Usually this has been recorded as on floating sea-weed, but this collection contains a few specimens attached to pebbles, the only case I have noted as varying from that usually accorded to it.

Pasythea dubia, sp. nov.

Plate **1**, fig. 5.

At Hong Kong May 15, 1922, was taken (by Campbell) a small colony of Pasythea apparently new, though with certain doubtful features to be noted in later connection. Its habitat was, like that of *P. quadridentata*, on the floating sea-weed, over the fronds of which it crept in the same fashion. The following are distinctive features: —

Trophosome.— Stems simple, of varying height from 10–15 mm., arising from a creeping stolon from spurs of which they spring. As in the former species, the stems are composed of a series of segments (Plate **1**, fig. 5), made up of hydrothecae in pairs, usually in this species a single one to each segment, or internode. But in nearly every case certain internodes will bear two, three or rarely four, hydrothecae. Nodes are of two sorts, the simple or right-angled, or as in the former species, oblique; in the latter when composed of two or three pairs of thecae. In cases of but one pair on an internode there will seem to be lacking a definite nodal joint in many cases. Hydrothecae are very similar to those of the former species as to size, shape, etc., but slightly smaller and with but two teeth which are lateral, and no definite opercular valves.

In size this species is slightly smaller than *P. quadridentata*, by about 25%, as determined by series of measurements.

In this species the gonosome is lacking, which leaves some doubt as to specific distinctness, yet other characters seem sufficient to make rather certain its specific difference.

The species is remarkable for its high variability.

Diphasia Agassiz (in part).

Trophosome.— Hydrocaulus similar to others of the Sertularidae, hydrorhiza a creeping stolon, from which stems arise. Hydrothecae in biserial, opposite or alternate, aperture wide, with single adcauline operculum.

Gonosome.— Gonangia conspicuous often with spines over the surface; they differ in the two sexes, that of the female with an internal marsupium; male smaller, and with tubular orifice.

Diphasia dubia, sp. nov. (?).

Plate **1**, fig. 2.

Very small colonies of this hydroid, with fragments of *Pasythea quadridentata* and other hydroids, but devoid of gonangia, makes definite specific determination doubtful. In general it resembles *D.*

attennata Hincks, in its trophosome aspects, the more delicate, and apparently immature. The tendency to bear terminal tendrils, after the manner of several other species, *e. g. D. fallax* and *D. attennata*, is also found in these specimens. But the hydrothecae, while like *D. attennata* in diverging from branch or stem for about half their length are much more abruptly divergent, almost at right angles, while in the former species this is very gradual and gently curved.

Billard has described (1920, p. 144) a very minute species, *D. minuta*, 0.5 cm. high, which resembles *D. dubia*, though its minute size, as well as other features, is in rather marked contrast to *dubia*.

The following are distinctive characters of the species: —

Trophosome.— Stems mostly simple, or with occasional branches, arising from stoloniferous hydrorhiza, which creep over other hydroids, or similar supports. A feature already noted, that is, terminal tendrils, are frequently present. Hydrothecae are of the usual Diphasia aspect, adnate to stem or branch for half their proximal length, then sharply divergent, and with smooth margins, closed by adcauline opercula, a single pair on each internode.

Gonosome.— Not present in these specimens.

In view of the lack of gonosomes it seems best to designate the species as doubtful, leaving final confirmation to material in which gonangia are present.

Plumularia Lamarck (in part).

Trophosome.— Hydrocladia, unbranched, pinnately arranged, either alternate or opposite, devoid of accessory branches, each bearing more than one hydrotheca, the latter with smooth margins. All of the nematophores motile.

Gonosome.— Gonangia, borne on the hydrocaulus or hydrocladia, simple and flask-shaped.

Plumularia badia Kirchenpauer.

Plumularia badia Bale, Catalog Austr. zoophytes, 1884, p. 128.

Several colonies were found among a mass of other hydroids having the following general features; the stems arising from complex root-like hydrorhiza are of dense and horny texture, height 40–50 mm. or more; from the main stem are given off at irregular intervals branches, both of which are divided into segments or internodes, which bear two to three hydrotheca, and divided by oblique nodes. Hydrocladia are also borne on the main stem as are its branches. The general aspects of the trophosome resemble that described by Billard, but in distinctive details there seems to be specific differences.

Only two gonangia were found apparently attached by foot pedestals to the stem contiguous to the point of origin of a hydrocladium. These seem to be immature and are rather small, obconic in shape and truncate at the apex.

Plumularia lagenifera Allman.

Journ. Linn. soc. zool., 1885, **19**, p. 157, pl. 26, fig. 1–3. Nutting, Amer. hydroids, 1900, pt. 1, p. 65. Fraser, Bull. Lab. nat. hist. State univ. Iowa, 1911, **6**, no. 1, p. 82. Trans. Roy. soc. Canada, 1914, **8**, p. 209.
Plumularia californica Marktanner-Turneretscher, Ann. K. k. nat. hofmus., 1890, **5**, p. 255, pl. 6, fig. 4.

This hydroid was found growing on fronds of Algae, the hydrorhiza creeping over the fronds, and from the stolons stems rising to a height of ten to twenty mm., unbranched, composed of a series of internodes, each of which bore a single hydrocladium at its distal node, alternating with that of the next, and thus giving a pinnate effect of the delicately beautiful organism. Each hydrocladium arose from a stout spur of the distal end of the internode and bore from two to three minute cup-like hydrothea, with a pair of supracalycine nematophores at its articular surface. Each hydrotheca bore a median nematophore.

Gonosome.— Gonangia (male) are borne on the spur from which hydrocladia arise, are ovoid in shape, about as long as the internode with a long terminal pore from which the contents escape.

Plumularia setaceoides Bale.

Cat. Austr. zoophytes, 1884, p. 136.

Several fine colonies of this hydroid were taken and identified as belonging to this particular species described by Bale. Sometimes unbranched, 30–50 mm. high, from a network of stolons. Stems, dark brown, made up of regular internodes and marked by distinct transverse nodes each with a single hydrocladium borne on a spur at its distal end, these arranged alternately in pinnate fashion.

Gonangia are lacking in these specimens, but the trophosome seems so similar to that indicated that I do not hesitate to include it as a member of this species, though there are variations which leave some doubt on this point.

Lytocarpus Kirchenpauer.

Trophosome.— Stem fascicled; hydrothecal margin toothed or sinuous; mesial nematophores usually with two openings, a perforated opening near the base of the free portion, and the terminal one at the tip.

Gonosome.— Gonangia borne on hydrocladia which are modified to form protective branchlets, often resembling a corbula.

Lytocarpus spectabilis Allman.

Rept. sci. results Challenger, 1883, **7**, Hydroida, pt. 1, p. 43.

Lytocarpus phoenicius Bale, Cat. Austr. zoophytes, 1884, p. 27. Billard, Ann. sci. nat., 1910, ser. 9, **11**, p. 48.

In the outer harbor, Amoy, October 24, 1922, a considerable mass of hydroid material was taken by Messrs. Campbell and Light, among which the most conspicuous and abundant was the above-named species, first described by Allman in full details, and well illustrated, leaving little necessity for additional account here except on points of variation, etc. The specimens here under review agree in general aspects of shape with those of Allman, except in size. These averaged about 50–75 mm. in height, as contrasted by the larger dimensions given by him.

Trophosome.— These specimens arise from a reticulated hydrorhiza; stems fascicled, stout, and branching in a generally opposite, sometimes alternate, fashion, each branch bearing closely set hydrocladial pinnae, forming a beautiful feather-like colony. Hydrocladia are also borne on the main stem and branches.

Hydrothecae, a single one to each internode, rather wide, with open mouth of sinuous form, with anterior parietal fold, and very short intrathecal ridge; mesial nematophore heavy, adnate to the walls of hydrotheca for slightly more than half its height, then extended free as a spine-like process, slightly beyond the hydrothecal margin, with an opening on the upper surface close to the hydrotheca, as well as the terminal pore. In these specimens the nematophores showed delicate threads protruding from their terminal pores.

Bale (1887, p. 87) has strongly asserted the identity of Allman's species with *L. phoenicius* Busk, as does also Billard (1910, p. 49), who gives a figure of the type material in the British Museum. But the material here concerned shows none of the varietal aspects claimed by these authors, and does confirm that described by Allman, especially the hydrothecae,— the main feature challenged.

It is much to be regretted that the specimens are devoid of gonangia, since Allman's figure and description leave much to be desired. In addition this would go far to remove doubt as to the precise specific relations in question. In the circumstances my convictions support the views of Allman and are affirmed without hesitation.

Lytocarpus nuttingi, sp. nov.

Plate **2**, fig. 2. Figure 5.

It is interesting, not to say unusual, to find in the same collection and taken at the same place and time, two species of this rather rare genus. In general features the species here concerned is very different from the previous one. The former is coarse, heavy, flabellate in shape; the present is delicate, lighter in color and graceful in form.

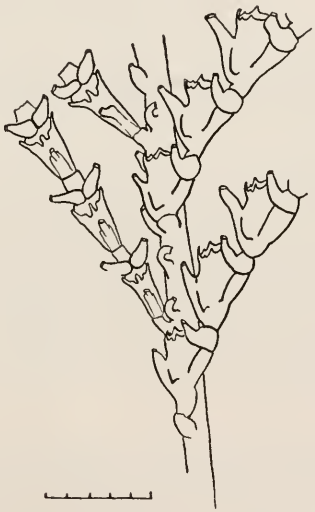

Fig. 5.— Lytocarpus nuttingi Hargitt.
G. T. H., del. 1/100×.

Trophosome.— Stems erect, fascicled in mature specimens, 4–7 cm. high, branching irregularly. Hydrocladia on both stem and branches, arranged alternately in pinnate order, as in the preceding species. Nematophores borne on both stems and branches. Hydrothecae borne on front or face of hydrocladia, one to each internode. Nodes of stems generally oblique, those of hydro-

cladia square, the margin irregularly toothed, intrathecal ridge but slightly marked.

Gonosome.— Only a few gonangia-bearing specimens found, in these borne on modified hydrocladia, and forming an open or pseudocorbula, similar to that of *L. spectabilis*. The gonangia are borne in a row on the rachis, the cladocarps arching in series on each side.

An interesting feature of the gonangia is the presence of male and female within the same phylactocarp as shown in Figure 5. This statement is made with some hesitation, since in most hydroids the sexual colonies are monogamous, though exceptions are well known. In the case of *Clava leptostyla* I described (1906, p. 211) a case of mixed sex gonophores, or hermaphroditism, and cited other cases of similar character.

Halicornaria Busk (in part).

Trophosome.— Stem non-fascicled, no posterior intrathecal ridge, an anterior intrathecal ridge usually present, hydrocladia unbranched, internodes devoid of septal ridges.

Gonosome.— Gonangia borne on stem or on bases of hydrocladia, not replacing hydrothecae, and not protected by corbulae or phylactocarps.

Halicornaria speciosa Allman.

Mem. M. C. Z., 1877, **5**, p. 74. Nutting, Amer. hydroids, 1900, pt. 1, p. 127.

Fine colonies of this hydroid were collected by S. F. Light, at Amoy, China, 1924. First inspection gave the impression of a single colony of large size, 5–8 cm. in height, but more critical study showed a complex of colonies arising from creeping stolons from which separate stems arose having a height of 3–4 cm. The following are distinctive features.

Trophosome.— Stems erect, arising from a complex stoloniferous hydrorhiza, in these specimens attached to a dead alcyonarian stem, to a height of 3–5 cm.; monosiphonic, bearing pinnate hydrocladia which appear to be alternate, a pair from each internode and extending in lateral order producing a beautiful frondose aspect. Hydrothecae, one to each internode, are as described by Allman and Nutting.

Gonosome.— These organs are borne in numbers on mature specimens, and in shape as described by the above-named authors. I must differ in one particular as to their location; namely, that each gonangium is borne on the basal internode of the hydrocladium as may be early demonstrated by careful detachment of the hydrocladium from the stem.

Aglaophenia Lamouroux (in part).

Trophosome.— Stems mostly monosphonic: hydrothecae with dentate margins: one mesial, and two supracalycine nematophore attached to each hydrotheca.

Gonosome.— Gonangia inclosed in a true corbula which may be closed or open, formed of modified pinnae, the leaves devoid of hydrothecae at their bases.

Aglaophenia amoyensis, sp. nov.

Plate **2**, fig. 3.

Several colonies of a minute hydroid varying in height from 8–12 mm. were taken by Mr. Light, some with a habitat among sponges and bryozoans, another on the tip of a dead stem of an alcyonarian, which in turn was fairly encased by an undetermined coralline, the whole having the aspect of a miniature palm.

Trophosome.— Colonies small, 8–12 mm. in height arising from stoloniferous base, massed on the summit of a dead alcyonarian stem as noted above, which by continued growth on a restricted area formed the beautiful palmate tuft. Stems segmented, each internode bearing a single hydrocladium from its distal and from which are borne regularly five or six hydrothecae, one to each segment, the margins with about 8 acute teeth. The mesial nematophore directed outward just below the margin of the hydrotheca; supracalycine nematophores rising slightly above the hydrotheca. The basal nodes of the stem are very oblique and deep, those of hydrocladial portions being rectangular and shallow.

Gonosome.— Gonangia borne on the rachis of the corbula and protected by the open arches of the phylactocarps, the outer surface of which bear paired nematophores (Plate **2**, fig. 3).

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EXPLANATION OF PLATES.

PLATE 1.

PLATE 1.

Fig. 1. Diphasia dubia Hargitt.
Fig. 2. Pasythea quadridentata (Ellis & Solander).
Fig. 3. Aglaophenia amoyensis Hargitt.
Fig. 4. Thuiaria tubuliformis (Marktanner-Turneretscher). Male.
Fig. 5. Thuiaria tubuliformis (Marktanner-Turneretscher). Female.

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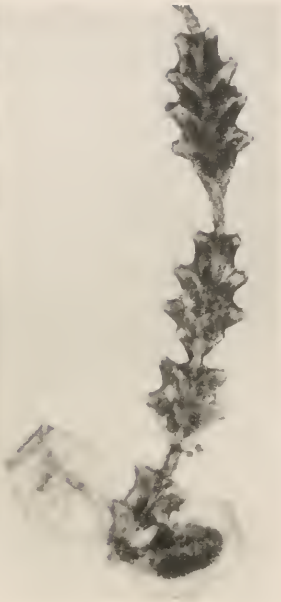

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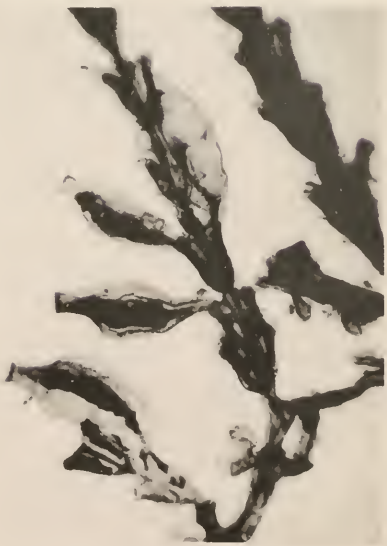

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PLATE 2.

PLATE 2.

Fig. 1. Eudendrium pusillum amoyicum Hargitt.
Fig. 2. Lytocarpus nuttingi Hargitt.
Fig. 3. Hybocodon amoyensis Hargitt.
Fig. 4. Eudendrium californicum Torrey.
Fig. 5. Pasythea dubia Hargitt.

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